MOBILITY CONCEPTS AGENCY
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POWER PROJECTION

Mobility Times

VOLUME 7 APRIL 1996

The Mobility Concepts Agency (MCA) periodical is published quarterly. MCA is a multi-Service organization sponsored by the Army Training and Doctrine Command (TRADOC) and the Air Mobility Command (AMC). The periodical is governed by Army Regulation 25-30, chapter 10. It is intended to be a vehicle for disseminating current mobility information and for discussing new concepts and ideas in the mobility arena. Since the periodical is an open forum, the articles, letters, and opinions expressed or implied herein should not be construed to be the official position of TRADOC, AMC, or MCA. Articles, letters, and opinions are welcome and should be sent to Mobility Concepts Agency, ATTN: ATDO-MCA, Ft. Monroe, VA 23651-5000.

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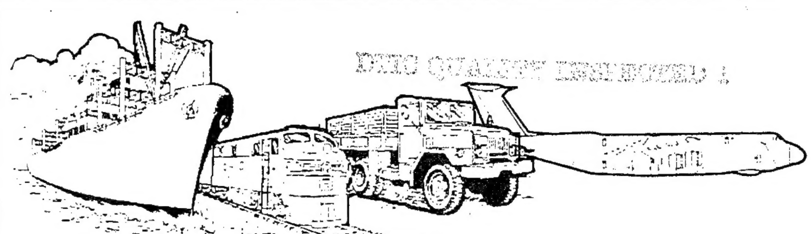

DIRECTOR'S COMMENTS

Just prior to MG Scales arrival as the DCS for Doctrine (DCSDOC) in February 1996, he ordered several copies of two books and distributed them to each division including MCA and the AirLand Sea Applications (ALSA) Center. He directed all personnel to read these two books to understand how critical doctrine is in determining a nations overall warfighting capabilities and how important it is to get doctrine right the first time or you may be doomed to failure. "The Seeds of Disaster" by Robert A. Doughty details the development of French Army doctrine from 1919 to 1939. "The Roots of Blitzkrieg" by James S. Corum does the same for Germany during the same period. Obviously, Germany got its doctrine right and France didn't. In the first book the author develops the argument that doctrine, not politics, a lack of intellect, or poor training, caused France's debacle against the German blitzkrieg in May-June 1940. Simply put, the French Army developed a doctrine which trained and equipped its soldiers for the type of warfare fought in WWI, just the kind of warfare Germany wanted to avoid. In essence, due to its doctrine, France was trained and equipped for the wrong kind of war.

Ironically, Germany's loss in WWI was partially responsible for its initial WWII successes. At the end of WWI, the country had no military equipment and no standing Army. Germany had to develop its armed forces from a clean slate under the shadow of the Versailles Treaty. Therefore, its ability to create new doctrine was not burdened by expensive equipment left over from the war or a staff weighted down by old think and old paradigms (as was the case in France). The developing Army was willing to "think out of the box" and test new doctrine. The clean slate effect resulted in the development of weapons and tactics that provided "shock, speed, and mobility", and soldiers that emphasized "offense, initiative, and flexibility", characteristics which proved deadly for Germany's opponents in the next war.

Now, before this turns into a history lesson, let me get to the point. One of the current buzz words around TRADOC today is "Army After Next" or "ANN", which is a vision of the future Army. Most of us have heard the term "Force XXI" which refers to the process the Army will use to develop its next two Armies--Army XXI which will be operational about 2000 and AAN which will be the Army after Army XXI, and be operational around 2025. It's interesting to note most of the warfighting equipment the Army depends on today and will depend on for Army XXI will be obsolete between 2010 and 2015. This includes the M1A1 and 2 Abrams tank and M2A3 Bradley fighting vehicle. In effect, the developers of AAN have guidance to think out of the box, look at what warfare will be like in the future, and then develop the weapons systems to ensure America wins its 21st century battles.

Fortunately, the same kind of vision making process is also going on in other areas and organizations of the military. The Air Force has chartered "Air Force 2025" which will look at "alternative futures...and possible changes in doctrine." This, coupled with the "New World Vistas" will glimpse new and emerging technologies and how it will effect the "new way of war-exemplified by stealth, global mobility, long-range precision strike, information warfare, and the effective use of space." GEN Fogleman's directive is to "engage in maverick, out of the box thinking." U.S. Transportation Commands vision is called Defense Transportation System 2015 or "DTS 2015" and will develop and integrate the Nations defense transportation systems for the next century. Of course the Sea Services vision is "Forward, From the Sea" which will result in new weapons systems such as the arsenal ship and amphibious assault ships designed to rapidly project lethal power from the sea. Tying all these Service visions together is the CJCS "Joint Vision 2010" which should be out around the first of June 1996. It will provide the CINCs and Services with a vision of future warfighting for the U.S. Armed Forces.

It would appear to the most casual observer that the U.S. military is in a similar position France and Germany found themselves in 1918. Along with downsizing and reorganization, there were lots of new weapons systems and emerging technology (machine guns, tanks, airplanes, and gas warfare then; unmanned vehicles, airborne lasers, stealth, brilliant munitions, and information warfare now, to name a few) that required new strategic, operational, and tactical doctrine to put it all together effectively

and efficiently to forge a powerful military, capable of winning across the operational continuum. All of the emerging visions discussed above will eventually become concepts which will develop into our doctrine for the next century. It will be critical we get it right the first time because, as France found out in June 1940, there may not be time for the nation to recover from the effects of bad doctrine.

To get it right, today's leaders responsible for doctrine development must let the "iron majors" and civilian counterparts think out of the box and "argue openly for radical alternatives without penalty." It was this kind of open atmosphere that allowed Germany to transform "the mobile-war doctrine of the 1920's into the blitzkrieg concepts of the 1930's." Can the U.S. military do the same? GEN Hartzog, Commander, TRADOC, captured this philosophy very succinctly when he told his people to "think on the ragged edge of audacity." If we all do that, there is no question our future joint and service doctrine will be right for the 21st century and will help go a long way to help ensure success on the battlefield, in the air, or on the sea.

Oh, by the way, if you are interested in the specifics of the German and French doctrines, guess you will just have to read the books. But please don't do that until you finish reading this issue of the "Mobility Times." We have something of interest for everyone. As always, we are interested in your comments or ideas for future articles. See you next quarter!

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Purpose: The Mobility Times periodical is published quarterly by Mobility Concepts Agency (MCA) located at Fort Monroe, Virginia. MCA is a multi-Service organization sponsored by the Army Training and Doctrine Command (TRADOC) and the Air Mobility Command (AMC). The Mobility Times is intended to be a vehicle for disseminating current mobility information and for discussing new concepts and ideas in the mobility arena. It contains articles that enhance the exchange of mobility-related information among Services to promote more efficient/effective planning and power projection.

Approval Statement: *"The Secretary of the Army has determined that the publication of this periodical is necessary in the transaction of the public business as required by law of the Department. Use of funds for printing this publication was approved by the TRADOC Chief of Staff on 24 January 1996, in accordance with Army Regulation 25-30."* Since the periodical is an open forum, the articles, letters, and opinions expressed or implied herein should not be construed to be the official position of TRADOC, AMC, or MCA.

Mailing/Distribution: This publication is packaged for mailing by MCA and distributed by DOIM Mailroom, Bldg 183, McNair Drive, Fort Monroe, VA 23651-7051.

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NOTE: Articles, letters, and opinions are welcome and should be sent to HQ TRADOC, Mobility Concepts Agency, ATTN: ATDO-MCA, Bldg 176, Fort Monroe, VA 23651-5000. MCA reserves the right to edit content to meet space limitations and conform to MCA's style and format. **Next issue is July 1996. Please submit articles by 13 June 1996.**

Secretary of the Army: Mr. Togo D. West, Jr.
Commander, Training and Doctrine Command: General William W. Hartzog

JOINT RECEPTION, STAGING, ONWARD MOVEMENT, AND INTEGRATION (JRSOI) AND THE JOINT THEATER DISTRIBUTION MANAGEMENT (JTDM) SYSTEM

by
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Background

Few problems have been more vexing than those posed to the warfighting logistician when confronted with the need to distribute materiel, move forces, and accomplish logistics support in a theater of operations.

In recent contingencies, such as Operation Desert Shield/Desert Storm, even as tremendous personnel and financial resources were focused on identifying the mountains of materiel pushed into the theater, the problem of effectively and efficiently distributing the resources remained unsolved.

Additionally, the lack of management/operational visibility and controls forced planners and operators to order additional supplies far in excess of the real requirement.

Since the passage of the Goldwater-Nichols (DoD Reorganization) Act of 1986, joint commanders now have the authority to direct logistics support among and between their subordinate Service component commands and the responsibility for maintaining an effective distribution network. Rather than solely emphasizing concerns for efficiencies avoidance of duplication of effort, as addressed in earlier Defense Department guidance, the Commanders' in Chief (CINCs') enhanced logistics authority is primarily directed to the effective execution of their warfighting mission. As codified by the Joint Chiefs of Staff in Joint Publication 0-2 and subsequently, in Joint Publication 4-0, the joint commander is now empowered to "use all resources and facilities available as necessary for accomplishment of operational missions." Notwithstanding the new guidance, joint commanders have little doctrine, systems, force structure, policies, or procedures in place to replicate, oversee, or coordinate the distribution system management capabilities of the Services. In short, they have been provided new authorities and responsibilities but have no tools with which to execute these added responsibilities.

Joint Defense Total Asset Visibility (JDTAV) Office

The Joint Defense Total Asset Visibility (JDTAV) Office was established in the Summer of 1995 to look at these and other asset visibility problems and suggest potential solutions to many of the areas that are outlined above.

Joint Theater Distribution Management (JTDM)/Joint Reception, Staging, Onward Movement, and Integration (JRSOI)

One of the major areas of concern was the management of assets once received in the theater. Listed below are some of the problems and initiatives now being worked by this office to alleviate identified shortfalls in the theater distribution management area.

- CINC logistics staff organizations are currently handicapped through lack of information and supporting auto-communications. Today, their ability to accomplish logistics planning and execution is not responsive enough to meet CINC expectations. The introduction of the JTDM concept, supported by Joint Total Asset Visibility (JTAV) information system, and, Automated Identification Technologies (AIT), all integrated into component organizations and systems, will materially enhance logistics operations. The added visibility and control brought on by distribution-focused Horizontal Technology Insertion (HTI) into existing staff organizations appears to provide leap-ahead capabilities within current resource levels.
- To receive the information that a viable distribution system in the Theater of Operations (TOPNS) requires, it is imperative that the Service and national systems be enabled with the integration of the full suite of Automated Identification Technology (AIT) and communications technologies. While the Defense Logistics Agency (DLA), the Army, and Air Force have started this process, it is critical that it be completed in as expeditious a manner as practical.
- The introduction of a JTDM system, as a part of JTAV, will permit horizontal integration of distribution information to component and staff functional systems. This capability will cause the functionality of these systems to increase as the information provided by JTAV can be interchanged within these systems, the staff's decision-making process, and component logistics operations execution.
- One area not addressed, since it was outside of the scope of a CINC's theater distribution authority but critical to the Theater Distribution manager, is the requirement to gain and maintain visibility of direct vendor shipments. In developing this part of the system, it must be assumed that vendor container and "in-box" visibility will be provided from Service and defense systems. An increased DoD reliance on flow of materials from vendors directly into the theater can be anticipated. Visibility of these shipments must be gained as soon as practical. It is critical that attention be directed to integrating emerging auto-communications capabilities, such as electronic data interchange, from the civilian component into this system and, technically, into JTAV.

JTDM/JRSOI is a function of three critical components (visibility, control, and capacity) all requiring accurate, reliable, and up-to-date information. These three components allow distribution managers to accomplish the following:

- Project distribution pipeline volume, flow rates, contents, and associated node and port handling requirements.
- Adjust flow volume, contents, and routing in response to operational requirements.
- Establish and maintain Theater Total Asset and In-Transit Visibility for sustainment materiel.
- Break-bulk, re-consolidate, divert, and control the flow of multi-consignee shipments.
- Coordinate, align, and reconcile consignee receipt of materiel with In-Theater movement operations management.
- Retrograde, redeploy, and, or further deploy materiel.

The JTDM concept introduced by the JDTAV Office in January 1996 meets the design criteria and nine operational principles first outlined in the Draft Defense TAV Implementation Plan, dated 17 July 1995. Those principles include the following:

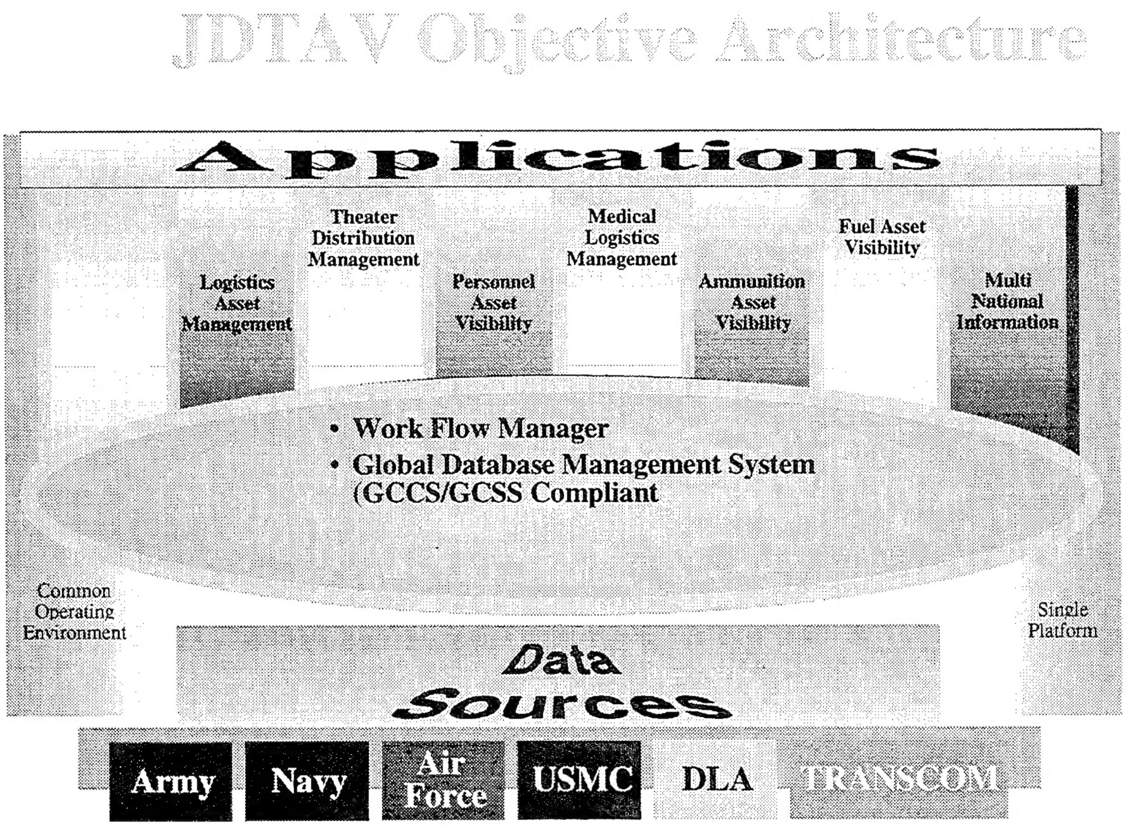
- Fully deployable and capable of supporting the CINC's requirements and those of all operating and supporting forces in theater.
- Operate the same in peace and war.

- Simple and easy to use.
- Use existing data.
- Compatible with existing Military Service applications.
- Timely and accurate.
- Reduce cost and improve efficiency.
- Support garrison, fleet, deployed, and non-deploying functions.
- Place no additional burden on operating forces.

Further, the JTDM concept is based on the premise that all necessary information already exists in, or can be easily imported into the theater, and that this information can be captured using existing technology and applied through Vertical Technology Insertion (VTI)/HTI enhancements and doctrinal changes.

Current Initiatives

To this end, the JDTAV Office, when presented with the challenge of working this total visibility area, came up with the architecture depicted below:



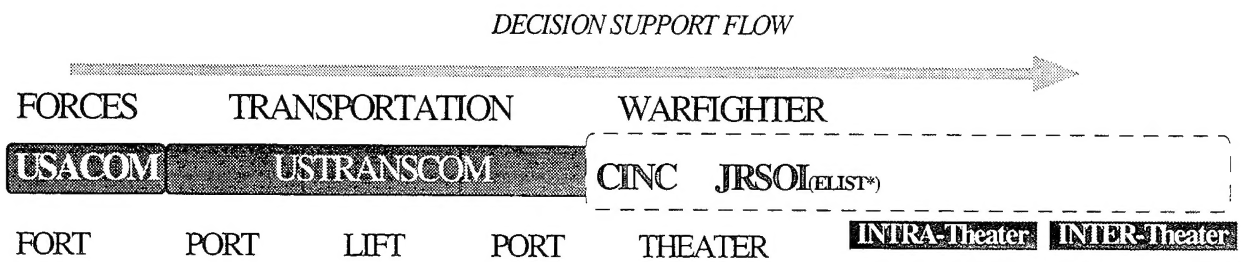
The JTAV "middleware" represented by the Global Database Management System (GDMS) is government owned software developed in the Joint Computer Aided Logistics System (JCALS) program. The reuse of this smart middleware will allow the JTAV system to access data from the source systems and make that data available to the applications shown, *invisible to the user*. Also, the Supporting CINCs have been building an end-to-end set of DSS tools that require a link between force planning/execution and the logistics sustainment data.

This JTAV system will also help bring those data elements together into one database system. The data utilized in force deployments and that required by MILSTAMP for the execution of sustainment are now being addressed. With this formatting problem solved, the CINCs planning suite of decision support tools will be able to use JTAV data for "forward look" planning during execution for both unit moves and sustainment. JTAV will provide the CINC/JTF the common database needed to synchronize the entire support structure and ensure the support needed to successfully accomplish the Course of Action (COA) selected. This system will also be able to address the planning and execution needs of redeployment missions.

Associated Efforts

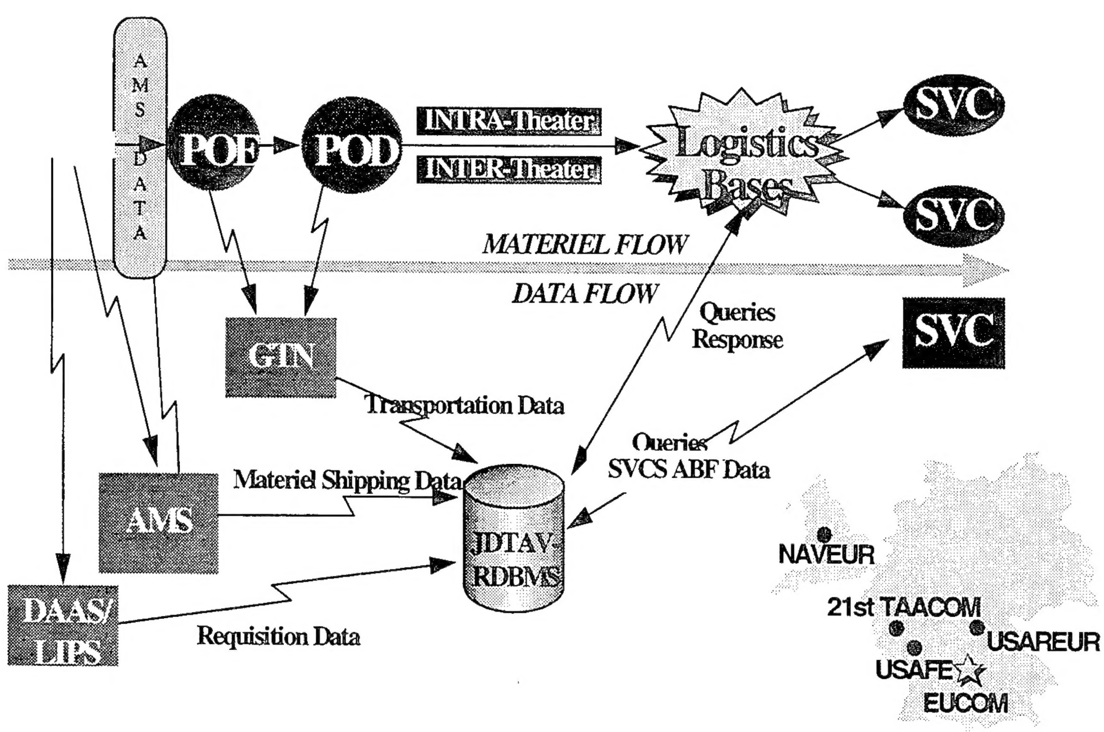
Closely tied to the JTDM effort in JTAV is the current Joint Reception, Staging, Onward Movement, and Integration (JRSOI) work ongoing with the Supporting/Supported CINC/JTF users. Pictured below is the Supporting CINC Decision Support System (DSS) initiatives started with a Memorandum of Understanding between USTRANSCOM and USACOM (Forces Command) to address the unit moves from the installation to the POD.

Another ongoing effort still to be accomplished is the Supported CINC JRSOI portion that will tie to the Supporting CINC DSS systems. This will then allow for on-line collaborative, interactive planning and execution between the Supporting and Supported CINCs. This could translate into identification of port throughput reductions or limited onward movement capabilities that were based on host nation support that no longer exists. One example of what this could mean to the CINCs is the alleviation of port "bottlenecks" that plagued the DESERT SHIELD deployments. The "push" system had many ships waiting in the harbor for berths at nearly $50K/day. Leaving the ships in home port until required would have cost only $5-10K/day. Problems like this can be actively pursued when the DSS tools are on-line with accurate and timely data to address the "what if" questions of any operation.

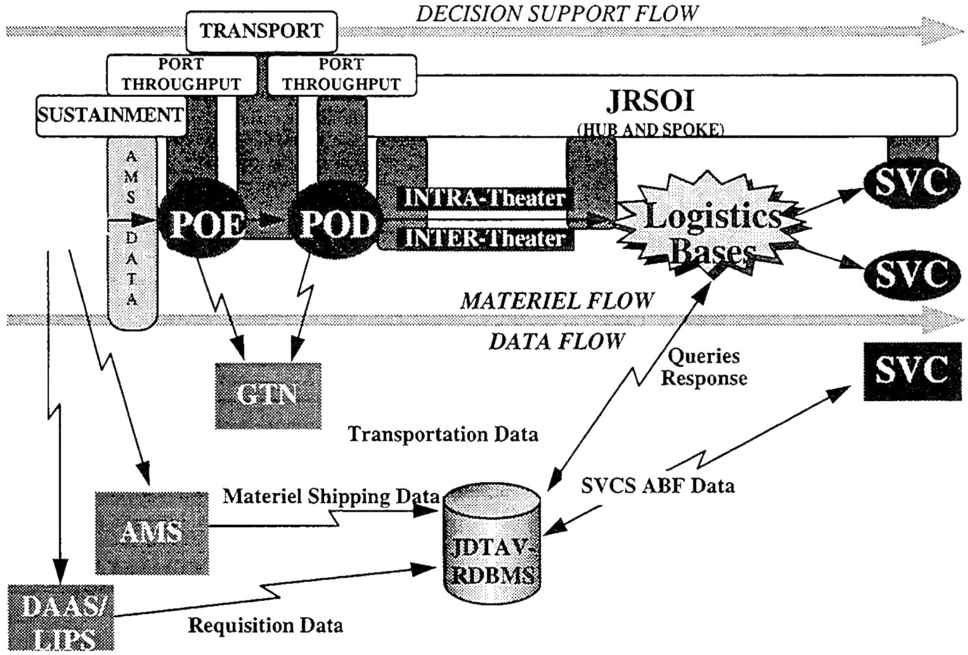


* One DSS JRSOI-related planning system already on-line in EUCOM is the Enhanced Logistics Intratheater Support Tool (ELIST).

The DSS part of the JRSOI will be supported by the JTAV/TDM data elements for deployment, sustainment, and redeployment requirements. Pictured below is the current JTAV system deployed to EUCOM in support of the Bosnian effort.



The key to a completed system for the Supporting/Supported CINC is the combining of the two parts shown above, a JTAV database made available in the right format to the DSS tools. The objective picture of the total system would look as shown below for the current DSS functionality provided by the supporting CINCs' systems in operation. The architecture required to support this functionality is being worked at the DoD TAV Office for a June 1996 release. The technical architecture will then be accomplished for a 1997 release.



While much remains to be completed in this end-to-end coupling of DSS tools and data to run them, the EUCOM support for the United Nations' "JOINT ENDEAVOR" is adding emphasis to the need for total asset and in-transit visibility and decision support tools to help decision makers manage these kinds of efforts. The DoD TAV Office, the USTRANSCOM Joint Transportation CIM Center (JTCC), the Services, the Supporting CINCs, and the Joint Staff are working together with the Supported CINCs to provide the required asset/in-transit visibility, and JRSOI capabilities for the "Warfighters" as we approach and enter the 21st Century.

THE REDUCTION OF UNCERTAINTY AND LOGISTICS SIMULATION

by
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Integrated Materiel Management Center

Claude Shannon, the acclaimed mathematician of the 1930's, once described information as "the reduction of uncertainty." Logistics Simulation provides the user various types of information that is designed to drastically reduce the uncertainty of going to war in the 21st Century.

Introduction to Log Lab

The Army Missile Command's (MICOM) Logistics Laboratory (Log Lab), established in October 1992, stated purpose is to evaluate new technologies for application in military environments to enhance the supportability of Army Weapon Systems. MICOM

Integrated Materiel Management Center (IMMC) and the MICOM Research and Development Center (MRDEC) established a partnership to conduct Logistics Research and Development to support Missile Command's two prime Program Executive Offices (PEO), the PEO for Tactical Missiles and PEO for Missile Defense. The Logistics Laboratory offers an ideal mix of sustainment players; providing skills and capabilities in research and development, logistics applications, and logistics policy.

The Log Lab currently has four major initiatives. These are (1) video assisted repair, (2) virtual repairer, (3) remote maintenance, and (4) logistics simulation. These initiatives all have direct bearing on improving sustainment of Army weapon systems. Each effort is being pursued to prove out technologies that have benefit to the soldier in the field. Working closely within the USA TRADOC Battle Lab environment, Log Lab has established a firm foothold in addressing the needs of the new Force Projection Army.

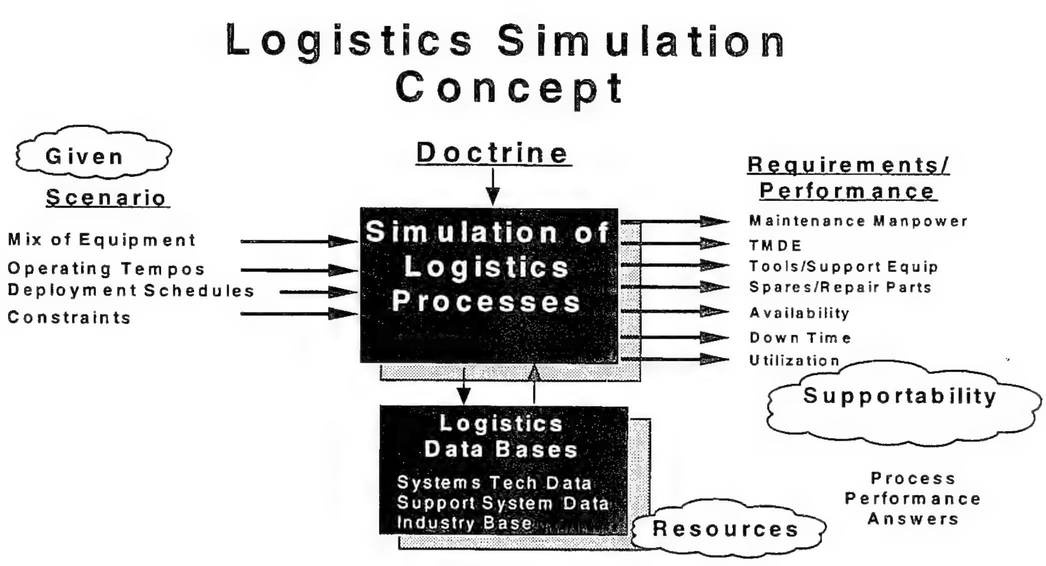
Key to the success of Log Lab efforts is the incorporation of simulation in the assessment of new technologies. The need for an all-encompassing, modular, flexible, platform-independent logistics simulation was recognized early on. A simulation is needed to function as the tool for assessing the utility of technologies being investigated for logistics application. To meet this goal in both the long-term as well as the short-term, a phased approach is being initiated to find and/or develop an objective logistics simulation.

Overview

The Log Lab approach taken to accomplish the development of a logistics simulation involved, first, identifying existing models/simulations that met the desired criteria for a logistics planning tool. The effort was completed in November 1993. Models have been identified and categorized by application to strategic, operational, and tactical logistics. The results identified deficiencies of the models to provide for "all-encompassing, modular, flexible, platform-independent" simulation for force sustainment.

Interfaces with existing force-on-force simulations (such as the Army's Vector-in-Commander Model) were also studied. The concept was to incorporate logistics processes that could be taxed by the warfighting simulation results. We had to address the build-up phase of a deployment and the actual conduct of the simulated battle support system in order to achieve the goal of the simulation. (The Army's efforts to generate a Battle Lab Reconfigurable Simulator Initiative (BLRSI) will provide the mechanism to address this concern. The BLRSI effort was initiated on 5 December 1995.)

The criteria for meeting the goal of an objective logistics simulation was always of primary concern. Building this capability, it was hoped, would offer the Log Lab a broad-based software package capable of emulating the logistics environment "from the factory to the foxhole."



The concept for a logistics simulation encompasses inputs, outputs, and control mechanisms.

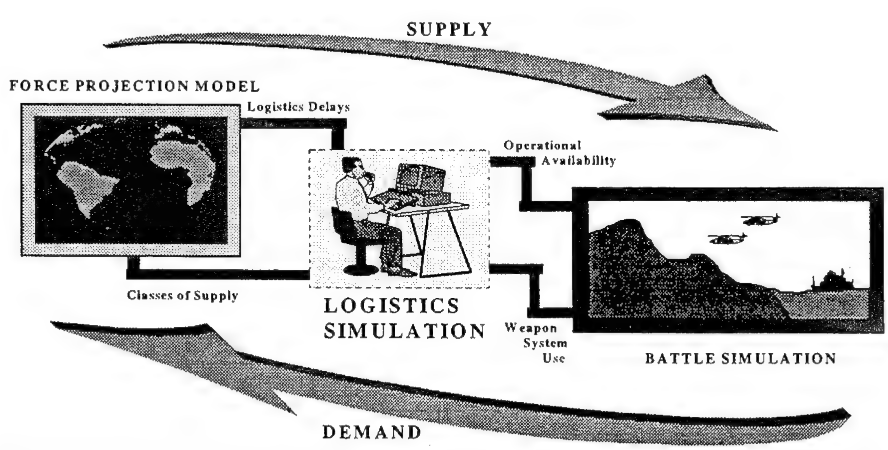
Logistics Development Environment

MICOM's Integrated Material Management Center (IMMC) mission is to provide logistics support for all MICOM-managed weapon systems. This involves supporting a variety of hardware items; including unmanned ground vehicles, unmanned aerial vehicles, air defense missiles, fire support missiles, ground-based sensors, radar frequency interferometers, night sights, smart munitions, and other highly complex systems. The biggest problem facing the IMMC is to make this support available anywhere in the world. At the same time, efforts are underway within the command to ensure that MICOM systems are affordable, maintainable, and reliable. A significant portion of this effort involves support for software. A method is needed to assess improvements to those processes associated with supporting fielded software.

Current methods employed to identify product/process improvements involve the extrapolation of field data and then applying a static, deterministic modeling capability. This can be time consuming and the support requirements do not accurately represent specific system deployments. This process worked relatively well when our forces were concentrated in well defined theaters of operations. Applying this process to the current defense environment of providing timely, flexible, and modular power projection to anywhere in the world is extremely difficult and subject to error.
The logistics simulation capability being addressed by Log Lab offers a solution to the IMMC's goal of supporting world-wide deployments of MICOM systems. The logistics simulation offers a flexible, scenario-driven tool that will represent a portion of the world and the logistics environment that will be encountered in supporting force projection deployments. By building the "as is" processes, shortcomings in the logistic support for MICOM systems can be determined and possible solutions identified. In addition, the simulation can be used as a planning tool for contingency operations and Operations Other Than War (OOTW). The simulation offers the tool most needed by MICOM logistics analysts to assess the validity and utility of introducing new technologies and improved processes into MICOM systems.

The Army's Early Entry Lethality and Survivability (EELS) Battle Lab (BL) at Fort Monroe, VA, charter includes the mission to "optimize force mix configurations for early entry deployment to improve mobility, survivability, and sustainability of early entry forces." The Logistics Simulation capabilities resident in the Log Lab will be used to support EELS Force Projection Modeling sustainment issues. The model developed by Log Lab will be used to assess strategies for determining Time Phased Force Deployment Data (TPFDD) ("push") support packages and for sustainment ("pull") support requirements. This simulation will be used in conjunction with the Military Traffic Management Command-Transportation Engineering Agency (MTMC-TEA) Force Projection Model (FPM) to derive early entry deployment and sustainment requirements.

LOGISTICS SIMULATION



The Log Simulation will link the force deployment activity with the combat simulation.

The Air Force Institute of Technology (AFIT) at Wright-Patterson Air Force Base in Dayton and MICOM have agreed to jointly pursue development of a Logistics Simulation. The School of Systems and Logistics has identified the need for a computer simulation to enhance and modernize classroom training techniques. AFIT is looking to encompass simulation techniques for use in the Logistics Planning Exercise (LOG-PLAN-X) utilized during the course. The student manual for LOG-PLAN-X will be used by MICOM as source material in accomplishing software development for the simulation.

Simulation Development and Technology Demonstrations

The Phase I Small Business Innovative Research (SBIR) program was initiated to investigate the feasibility of creating a logistics simulation utilizing "leap ahead" software technologies. This program is a DoD program to fund research efforts of small businesses who possess strong research and development capabilities in science or engineering. Log Lab solicited proposals for the topic, "Logistics - Sustainment Technical Assessment Simulation." The Phase I effort was awarded to American Power Jet (APJ) Company, Ridgefield, NJ, in March 1994. APJ developed a prototype simulation titled "LOGWARRIOR." This effort was completed in September 1994. The research conducted verified the technical feasibility of applying Object Oriented Design and Programming to attain variable resolution as well as providing for a high degree of modularity. A demonstration version of the model provided evidence of the capability that might be possible for an objective logistics simulation.

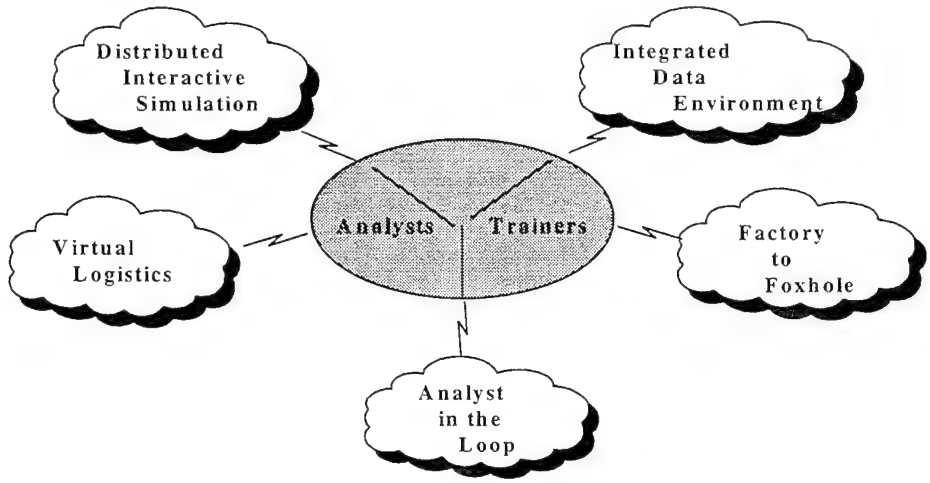
Log Lab then turned its attention to obtaining potential customer funding for development of the logistics simulation. The EELS Battle Lab provided funding to Log Lab for pursuit of this simulation in support of its "sustainability of early entry forces" mission. Additional funding was provided by AFIT for development of a "school-house" model for course development. Log Lab awarded a contract to Thinking Tools, Inc., Monterey, CA, in October 1995. This model will provide interconnectivity to combat simulations and support joint service application. In addition, it will have an object oriented architecture, be reconfigurable for various applications and scenarios, and allow quick response decisions. The model must also contain the capability to perform technology assessments. It will also assist in training logistics planners and managers. This project is expected to be completed by September 1996.

Key Features

The ultimate objective is a simulation that incorporates Object Oriented Programming (OOP) and provides for a user friendly interface. This will offer the flexibility needed in simulating various wartime and peacekeeping scenarios as well as offering the opportunity to introduce varying supportability and supportability-related technologies. OOP enables the development of a simulation that is more easily extended and maintained, allowing for a more complex simulation with a higher fidelity. This capability will enable easier communication with the tactical community by allowing the logistician to show impacts at the tactical level. OOP allows the simulation to be easily modified to meet changing needs.

A key aspect of the simulation is flexibility for use by logistics planners, analysts, and trainers. The model will be able to play within the Distributed Interactive Simulation (DIS) world; allowing for interaction with a wide gamut of wargames and simulation exercises. Defense Mapping Agency (DMA) data will be evaluated for potential use in the simulation; leading to the establishment of necessary protocol exchange requirements. By providing interactive, graphical user interface, the model will present users with a direct window to the military services Integrated Data Environment. Advancing the state-of-the art in software technology, the model opens up the user to the potential for working in a virtual logistics world; allowing for entry into a "factory to foxhole" logistics environment.

Logistics Simulation Architecture

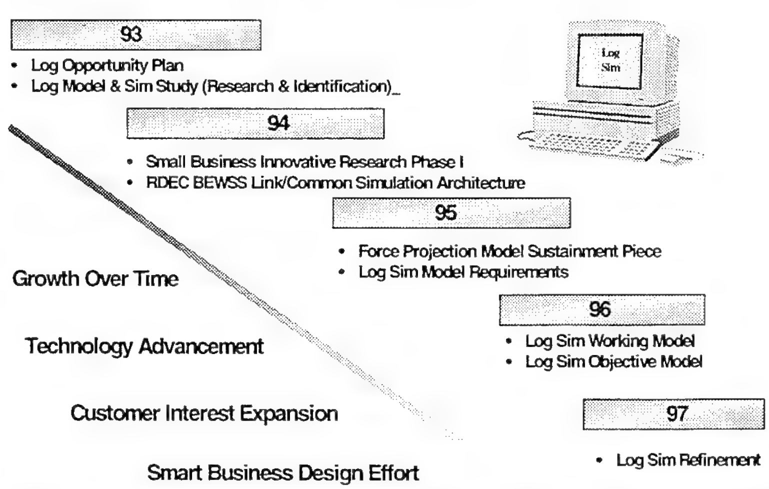


Multi-functional users will have the capability to access new, expanded views of the logistics environment.

Strategy for Success

Log Lab has pursued a strategy that builds on expansion of capabilities over time. By maintaining close communications with the User (military) communities, customer interest in the project continues to build. From the initial effort to evaluate existing models and simulations to the contract mechanism with Thinking Tools, Log Lab has sought to advance the need for and the understanding of an objective Logistics Simulation. Log Lab efforts are directed at leveraging the latest technological advances in software development. There is a high degree of confidence that the final product will address all the criterion desired for meeting the analyst, trainer, and planner's needs. Application of smart business practices in system design will ensure a workable, usable, and flexible end product.

Logistics Simulation Marketing Strategy



A strategy of growth, technology advancement, customer satisfaction, and best business practices.

Vision for the Future

Log Lab will continue to take advantage of every opportunity to work with all organizations involved in logistics simulation. Coordination with the TRADOC Battle Lab provides the mechanism for implementation of TRADOC requirements in the simulation. Continued interest by other Service elements offers expansion opportunities into joint exercise modes of logistics simulation. Key to the entire effort may be the institutionalizing of the simulation. This can be accomplished by continuing to work with service schools such as AFIT, the Army's Logistics Management College (ALMC), and the Defense Management System Center (DMSC). Whatever the avenues, Log Lab will continue to pursue the application of Logistics Simulation technologies wherever the interest and need arises. This will guarantee the reduction of "uncertainty" for tomorrow's war planners well into the 21st Century.

Biography

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RETIRING THE C-141 STARLIFTER--ARE WE READY?

by

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Mobility Concepts Agency

It is hard to believe 35 years have passed since President John F. Kennedy, on 13 March 1961, authorized procurement of the Lockheed C-141 Starlifter. According to President Kennedy, "It was useless to have 17 [active] divisions if they could not be transported anywhere in the word in 24 to 48 hours."[1] The U.S. military needed rapid, long-range airlift and the C-141 was the answer. Although its importance has been downplayed through the years, a big part of C-141 history includes tactical (theater) airlift: intratheater cargo and personnel transport, strategic brigade airdrop capability, primary nuclear airlift, ballistic missile movement, special operations augmentation, and aeromedical evacuation.

The Starlifter has performed admirably as the United States core airlifter over the last four decades, but structural integrity, maintainability, and reliability issues have surfaced that question its longevity. In 1990, Lt Col Steve Wilson, HQ MAC/XRSL, drafted Military Airlift Command's (MAC) position. It marked the beginning of the end for the C-141. It stated "Any effort to extend the life of the C-141 beyond the currently proposed 45,000 hours would be costly, fall far short of providing the required capability, and still be a risky proposition." Lt Col Wilson went on to accurately characterize the Starlifter as "tired iron."[2] The question then, is not if we should retire the Starlifter, but **Are We Ready**?

Final phase-out of the C-141 is scheduled for 2006 (Active Force--2003). However, Air Mobility Command (AMC), formerly MAC, has not yet determined how many o the Starlifter missions, if any, will transfer to other aircraft. AMC has formed a C-141/C-17 transfer of missions working group.[3] Yet, with only 120 C-17s, this fleet will be very busy carrying out the strategic airlift mission leaving only the C-130 to perform theater airlift. This dilemma is further complicated by the fact that theater airlift is now the responsibility of the geographic Commanders in Chief (CINCs) and Air Combat

[1] William Head, Dr., Reworking the Workhorse: The C-141B Stretch Modification Program, (Office of History, WR-ALC/HO, Robins Air Force Base, GA, September 1984), p. 4.

[2] Steve Wilson, Lt Col, C-141 Service Life Extension Program (SLEP), (HQ MAC/XRSL Position Paper, January 31, 1990), p. 5.

[3] Phil Bosset, Maj, C-141/C-17 Transfer of Missions Working Group, (HQ AMC/XPDI Point Paper, October 24, 1995.)

Command (ACC), not AMC. Also, the February 1995 National Military Strategy states "with fewer U.S. forces permanently stationed overseas, we must increase our capability to project forces abroad."[4] The goal is to balance reduced defense spending with an increase in strategic lift requirements while continuing to execute the current C-141 tactical airlift missions.

This paper traces the history of the C-141 Starlifter, including the origins of long range airlift and acquisition of the C-141. Then the current and future requirement for strategic and theater airlift is discussed. With the airlift requirement defined, the replacement alternatives for the retiring C-141 are examined. These alternatives focus both on the strategic and theater roles performed by the Starlifter, not just the capability to strategically transport tons of cargo. Finally, conclusions and recommendations for closing the strategic and theater airlift gap, created by the departure of the C-141, are presented.

Airlift Origins

Although limited air transport and airdrop capabilities were displayed during World Wars I and II, several crises following the war better demonstrated the importance of faster, more capable airlift. The Berlin Crisis in 1948, the fall of Nationalist China in 1949, American supply of resources to French troops in Indo-China, Soviet invasion of Hungary in 1956, and Middle Eastern Crises of the late 1950's were proof-of-concept for the strategy of air supply to conventional forces.[5] As we demonstrated, American defense policy was gradually shifting away from total nuclear dependence to a more conventional force requiring rapid deployment.

The first national policy statement on airlift was established in *The Role of Military Air Transport Service in Peace and War* completed in February 1990 by President Eisenhower's Secretary of Defense, Neil McElroy. Nine of its provisions directed commercial carriers, through the Civil Reserve Air Fleet (CRAF), to augment the military's need for airlift; Military Air Transport Service (MATS), in turn, was to provide the hard-core airlift. The U.S. Army, the primary airlift user, advocated the development of an aircraft that cold perform a variety of battlefield tasks--strategic and theater airlift, airdrop, and low-level flights. Although the Army was willing to accept a modified C-130 to accomplish this, Lt Gen William H. Tunner, MATS Commander, proposed 45 swing-tail jets to support Strategic Air Command, 49 additional swing-tail jets as an interim solution to Army requirements, 50 C-133s for outsized cargo requirements, and 188 jet aircraft designed to support Army requirements; which became the C-141.[6]

The MATS modernization plan was in place and ready for implementation; however, the DoD and Air Force Headquarters were not willing to make such a large investment in transport aircraft. It was not until the Kennedy administration that the C-141 acquisition program became a reality. This was due in great part to the efforts of former Secretary of Defense, Robert S. McNamara. Secretary McNamara felt procurement of this "revolutionary" medium-sized transport was paramount in the rapidly evolving flexible response strategy.[7] As a result, airlift was aimed not only at long-range support for U.S. nuclear forces, but also the Rapid Deployment of conventional forces, or as Secretary McNamara called it "flexible response to limited conflagration.[8]

Acquisition and History of C-141 Starlifter

With President Kennedy's authorization, Secretary McNamara's stimulus, and General Tunner's spark, the C-141A was finally on the way to earning its "workhorse" label. In his advocacy, Tunner remarked he wanted a "workhorse plane, cheap to operate, of indifferent speed, relatively large and easy to load."[9] What he got was an aircraft designed to carry all but 2 percent of an airborne division's equipment a distance of 5500 nautical miles at speeds up to 500 miles per hour. The C-141A had a maximum payload of 70,847 pounds (only 30,877 pounds with max fuel load of 153,350 pounds); maximum range of 5250 nautical miles with maximum fuel; 7340 cubic feet of cargo area with capacity to carry 10 pallets; capacity for 154 troops

[4] Joint Chiefs of Staff, National Military Strategy of the United States of America, (Washington, D.C.: February 1995), p. ii.
[5] Head, p. 3.

[6] Roger D. Launius and Betty R. Kennedy, "A Revolution in Air Transport: Acquiring the C-141 Starlifter," Airpower Journal, Fall 1991, p. 76.
[7] Ibid., p. 78.
[8] Head, p. 4.
[9] Ibid.

(123 troops with comfort pallets); and the capability to carry 8 litters with 8 attendants.[10] The Starlifter balanced a worthwhile mixture of advantages and disadvantages in terms of capabilities, price, durability, supportability, and quality.[11]

The first C-141A Starlifter was accepted by the Air Force on 18 August 1963. By January 1964, the C-141 was in full use with the last production model leaving the factory on 27 February 1968. Even though the C-141A could not carry outsized cargo like the C-124 or C-133, had a fuselage shorter than the C-133, and a smaller payload, slower cruise speed, and less range than the 707-300 or DC-8F, it quickly earned its "workhorse" role because of its near 500 MPH speed and ability to carry mid-size loads and troops. According to Dr. Walter Kraus in the preface to this monograph on the C-141, by the early 1970s the C-141 was the backbone of the Military Airlift Command's (MCA) operations; from 1964 to 1971 the Starlifters had flown almost 2.9 million hours.[12] General Tunner expressed it best, "The C-141 is more than just a plane. It signifies the return of our entire military program from almost sole emphasis on all-out nuclear war to the more practical preparation...for localized conflicts the free world constantly faces all over the globe.[13] More than three decades after these comments were first made, localized (regional) conflict is still the focus of U.S. National Military Strategy.

As the backbone of the MAC airlift fleet, the C-141 was beginning to make significant contributions to worldwide military operations. The Starlifter participated in such historical airlift events as *Operation Blue Light* (1965) the first large-scale airlift of an Army unit during the war in Southeast Asia; *Operation Eagle Thrust* (1967), the longest airlift of combat troops from the United States to a war zone (Vietnam) up to that time; *Operation Homecoming* (1973), the return of 591 American prisoners incarcerated in Indochina to the United States; and *Operation Nickel Grass* (1973), American support to Israel during the Yom Kippur War.[14] Even though these operations displayed the indispensable contribution of the C-141, they also exposed the limitations of the C-141A. *Operation Nickel Grass*, a spectacular display of United States airlift prowess and capability, demonstrated the critical need for inflight refueling and more airlift capability.

The C-141A was designed to supply NATO and Allied Forces in Europe and use staging bases in Europe to fly into the Middle East. The Yom Kippur War and oil supply problems in 1973 revealed basing rights and aircraft clearance problems that threatened to interrupt this flow. The United States needed a cargo aircraft, which would complement the newly acquired C-5 Galaxy. The aircraft needed to be lager than the C-141A, air refuelable, and cost-effective.[15] The solution was the C-141B, a stretched (13.5 feet Forward Plug Assembly forward of the wing and a 10 feet Aft Plug Assembly Aft of the wing), air refueling capable modification of the C-141A. Its procurement increased the fleets' cargo carrying capacity by 30 percent adding an equivalent of 90 additional aircraft.[16]

In June 1982, the final converted C-141"B" was delivered to the Air Force. Although this signified the end of the C-141A era, it did not denote the end of the Starlifter legacy. The 1980s and 1990s continued to see the C-141 perform the bulk of the airlift mission. Some of the more significant operations included *Operation Urgent Fury* (1983),

[10] Ibid., p. 9.
[11] Launius, p. 79.
[12] Head, p. 10.
[13] Susan Mercer Williams, An Airlift Odyssey: A History of Tactical Airlift Modernization, 1955 to 1983, (Lockheed-Georgia Company, Marietta, GA, IR&D 83D369, July 1983), p. 43.

[14] The Air Mobility Command (AMC) Office of History is a good source of notable airlift operations. Their publication Toward the Air Mobility Command: A Chronology of Tanker and Airlift Events, is an outstanding compilation of significant airlift events from September 1908 through June 1992. The operations listed in this article were extracted from the cited publication and other AMC Office of History material.
[15] Head, p. 18.
[16] Ibid., p. 19, 41.

the Grenada invasion; *Operation Haylift* (1986), airlift of 500 tons of donated hay to drought-stricken farmers in seven southeastern states; *Operation Just Cause* (1989), to oust General Manuel Noriega and restore democracy in Panama; *Operations Desert Shield and Desert Storm* (1990), United Nations effort to end Iraqi occupation of Kuwait; *Operation Fiery Vigil* (1991), evacuation of U.S. military and dependents from Clark AB and Subic Bay Naval Station to the U.S. following volcanic eruption of Mount Pinatubo; *Operation Provide Hope* (1992), relief to the former Soviet Union; *Operation Provide Promise* (1992), relief to Bosnia; and *Operation Restore Hope* (1993), assistance to Somalia. These operations combined to wear out this nation's core airlifter and accelerate its retirement.

Airlift Requirement: Current and Future

Can the warfighting airlift requirement be met without the C-141 Starlifter? The Mobility Requirements Study Bottom-Up Review Update (MRS BURU) determined a strategic airlift requirement of 49.4 million-ton-miles per day (MTM/D) is sufficient to carry out the two nearly simultaneous major regional contingency (MRC) strategy.[17] However, this only considers strategic cargo movement and ignores the tactical airlift contribution made by the C-141. These tactical missions cannot be classified in simple MTM/D terms. The strategic brigade airdrop, one of the current C-141 tactical airlift missions, continues to be an Army high priority requirement. If this requirement is not satisfied, the Army's warfighting effectiveness will be seriously diminished. Thus, with the impending departure of the C-141, mission transfer and acquisition strategy should focus not only on strategic airlift, but the theater airlift requirement as well.

But how can we determine these airlift requirements? There are several steps that must occur for the process to be successful. First, the principal warfighters (i.e., combatant commands) must precisely convey their needs without inflating their requirements. This is perhaps the weakest link. It is extremely difficult to accurately predict airlift requirements because it is so scenario dependent. In addition, one must determine what transportation mode is most efficient--airlift, sealift, or pre-positioned afloat--then assign the specific asset. This is the responsibility of U.S. Transportation Command (USTRANSCOM). Strategic airlift, because of its capacity orientation (i.e., MTM/D), is easier to determine and allocate. Theater airlift is much more difficult to quantify due to its dependence on combat events that may be unknown until initiation of hostilities. USTRANSCOM then looks to the Major Commands to supply the necessary airlift. AMC for strategic airlift and ACC (through ACOM) for theater airlift (although USTRANSCOM does retain command and control of some 50 C-130 theater airlift assets). When the geographic CINC (PACOM or EUCOM) has his own theater airlift assets, the components (PACAF or USAFE) are responsible for distribution of forces.

Although this is a rudimentary explanation of a complicated process, it does bring home the point that requirements must come first and from the warfighters. Yet, even though the war planning staffs have good intentions, historically their airlift requirements, particularly theater airlift, have been too fluid and ill-defined. The deliberate planning process, a vital piece of the Joint Operations Planning and Execution System (JOPES), attempts to define combat airlift demands, but is normally too rigid and inflexible. Thus, when a crisis occurs, crisis action planning is required to account for factors unknown during the deliberate planning process. In short, it is very difficult to accurately forecast current and future theater airlift requirements.

Since theater airlift requirements are so difficult to define, how do war planners validate the current C-141 tactical missions for use in the future (accepting MRS BURU as validation of the strategic requirement)? One of the most commonly used methods is to look back in history and ascertain what missions the Starlifter has been performing. Those missions that were assigned to the C-141 and continue to be performed are the tasks that most likely need to be discharged in the future. This approach assumes these specific missions have been "validated through accomplishment."

Air Mobility Command (AMC) appears to have taken this "mission validation" approach. Establishment of the C-141/C-17 Transfer of Missions Working Group confirms this assertion. The charter directs the working group to consider aircraft other than the C-17 and "scrub" the actual

[17] John A. Tirpack, "Airlift Moves Up and Out," Air Force Magazine, February 1996, Vol. 79, No. 2, p. 29.

requirement. Consideration of other aircraft and options is essential to avoid automatic selection of the C-17 as the best replacement aircraft.[18] Also, an Air Force only working group does not have the expertise to accurately identify (scrub) the warfighting requirement without input from the user. Nonetheless, by acknowledging the C-141 missions are still needed, AMC agrees the starting point must be to continue the current C-141 missions into the future.

Replacing the C-141

Before considering the alternatives for filling the airlift gap, one must remember the C-141 performs both strategic and tactical missions. This is not to imply the replacement must be an aircraft like the C-17 that can perform the full spectrum of airlift (although this is an option), but all of the current missions must be executed in the future. Also, the recent decision to buy 120 C-17s was primarily aimed at alleviating the strategic airlift shortfall. Thus, accomplishing the strategic mission in the future is not the real issue. Whatever systems replace the C-141 must be capable of performing the tactical missions. In other words, as the C-141 force draws down, what will take its place so theater airlift continues as a viable mission.

Three options are discussed that will accomplish this objective. Option one is procurement of additional C-17s to perform not only the strategic but the tactical mission as well. Option two recommends acquiring a stretched/air refueling capable C-130J. Finally, Option three advocates development of a new Advanced Theater Transport (ATT). The last two "tactical" options may require strategic augmentation. This augmentation should be in the form of increased use of commercial assets (civilian contracts, CRAF, etc.).

Option one employs the C-17 Globemaster III as the new strategic and theater core airlifter. This alternative has several advantages. First, the U.S. needs a new generation airlift "workhorse." According to MG Ennis C. Whitehead, Jr., USA (Ret.), the C-17 can perform all of the strategic airlift tasks: transport outsize, oversize, and bulk cargo; move personnel; conduct airdrops; perform aeromedical evacuation; and support special operations.[19] So, the Globemaster III is capable of performing all of the current C-141 missions. Second, the C-17 can operate into and out of small austere airfields and combat onload and offload easily, a capability the C-141 does not have. Finally, the C-17, when compared to other military and commercial strategic airlifters, has an increased throughput capability. This is based on better offloading and onloading design, improved ground maneuverability, and increased Maximum on the Ground (MOG) capability.

The leading disadvantage with Option one is its dominating focus on the strategic airlift mission. MG Whitehead, in his article, includes tactical missions such as airdrops, aeromedical evacuation, and special operations under the label of strategic missions. The integration of the tactical and strategic missions causes many to incorrectly link resolution of the theater airlift shortfall with that of the strategic. If the strategic airlift mission is allowed to encompass theater airlift, the tactical airlift missions could be neglected to the detriment of combat capability.

A second issue is use of the C-17 for the strategic brigade airdrop. Even though the warfighters need the capability to "strategically" transport and airdrop troops long distances directly into battle when time is critical, the effectiveness of this employment option is debatable. Limited numbers and availability of airlift and air refueling aircraft, coordination of arrival times over target, and troop fatigue are a few of the major difficulties in planning and executing an airdrop mission from the United States to a theater on the other side of the world (PACOM or CENTCOM). The optimum employment, if time permits, would be the massing of airborne troops and their equipment in theater or the adjacent theater (e.g., EUCOM supporting CENTCOM). In general, C-17 direct delivery capability is more efficient for strategically transporting equipment, not combat ready troops long distances directly into battle.

The same holds true for transporting casualties so far from the war zone. In the majority of cases, aeromedical evacuation is a theater airlift mission. Critically injured patients are normally stabilized at the front then transported to medical facilities within theater. Thus, the majority of the aeromedical

[18] Bossert, p. 1.

[19] Ennis C. Whitehead, Jr., USA (Ret.), "The Case for the C-17," Mobility News Bulletin, Vol. 3, April 1995, p. 6.

mission is within theater and does not require an aircraft such as the C-17 to perform it.

The C-17 is the best choice as the next core strategic airlifter. However, the acquisition of only 120 aircraft and the tremendous strategic lift demand may result in the decision not to use it in the theater role. This will make it very difficult to use as the next core theater airlifter or aircraft of choice for the strategic brigade airdrop unless more aircraft are procured specifically for the tactical airlift missions.

The argument is a doctrinal one. Operationally and logistically, strategic and theater airlift should be managed separately, just as strategic bombing and deep strike interdiction are looked at as two distinct missions even though the same aircraft can accomplish both tasks. Although command and control functions must be linked at some point during execution, aircraft acquisition, logistical support, and employment of assets require separate structures independently focusing on strategic and theater airlift. Thus, the issue is not whether the selected aircraft can physically accomplish all of the C-141 missions, but will the demand for strategic airlift in a contingency adversely affect its use as a tactical airlift asset. With the recent transfer of theater airlift assets to ACC and the regional commands, proponency of theater airlift has become convoluted. However, the principal user (Army) still requires a theater airdrop and airland capability, aeromedical evacuation, special operations augmentation, and basic theater airlift movement. The solution is to focus on these tactical airlift missions when determining a replacement for the C-141.

The second and third options assume the C-17 and future commercial augmentation will eventually satisfy the strategic airlift shortfall, but enhanced dedicated theater airlift aircraft will be necessary to fill the gap left by the departing Starlifter. Option two recommends enhancing the aged C-130 fleet. A one for one replacement of the older C-130E models with the modernized C-130J is not sufficient. In order to fulfill the tactical missions currently performed by the C-141, the baseline C-130J must be enhanced with aerial refueling capability and stretched (C-130J-30). A few of the advantages are dedicated strategic brigade airdrop capability, increased troop and cargo transport, and self-deployment capability. The remaining nuclear airlift and ballistic missile movement tactical missions can also be accomplished. In addition, the C-130J-30 will have better mission reliability, maintainability, and survivability, all-weather airdrop capability, and improved short-field performance. Still, the greatest advantage is procuring a theater airlifter (C-130J-30) to perform the theater airlift mission. Relatively low enroute airspeed (300-350 KTAS vs 410 KTAS for the C-17), less cargo capacity, and shorter maximum range are the major disadvantages when compared to the C-17.

Option three is very similar to option one in theory, but emphasizes the procurement of a "next generation" theater airlifter, the ATT. This option takes the previously mentioned advantages of dedicated theater airlift aircraft and improves on the concept. The McDonnell Douglas version of the ATT, for example, can carry larger and heavier loads like the C-17, contains a fully integrated cargo handling system permitting rapid forward area operations without any material handling equipment (MHE), and can support troops in forward battle areas much more directly and efficiently with its Super Short Takeoff and Landing (SSTOL) capability.[20] Although this concept may not be available now as a direct placement for the C-141, the tactical airlift possibilities this aircraft provides are enormous. Besides availability, the second disadvantage may be the available funding to procure this aircraft in the near future. However, the cost is still less than that for the C-17 ($80-$100 million per aircraft for the ATT vs $180 million per aircraft for the C-17).

Conclusions and Recommendations

The C-141 Starlifter fleet has been the backbone of U.S. airlift for four decades, but is tired and in need of replacement. The Starlifter has been involved in every major airlift event from the early 1960's through the present. Reliability and maintainability issues, as well as structural safety concerns, require the retirement of the fleet early in the next century. Even though this has been coming for almost a decade, transfer of missions and airlift acquisition questions still remain. The most significant problem is in fulfilling both strategic and tactical airlift missions simultaneously. Although we are well on the way to eliminating the strategic airlift shortfall, theater airlift capability will decrease as the C-141

[20] Mike Rohrlick and Blaine K. Rawdon, "An Advanced Theater Transport (ATT)," Mobility Times, Vol. 6, January 1996, p. 21.

retires. The C-130 has been the primary theater airlifter for the past 35 to 40 years with the C-141 also performing its share of the theater airlift mission--including the critical strategic brigade airdrop task. We must remember this fact as we determine the Starlifter's most effective replacement.

Assuming the C-141's strategic and tactical airlift missions are still required, based on historical performance of these missions, the challenge is to fulfill both types of missions without negatively affecting the other. Thus, it is not as simple as using the C-17. This aircraft is required more for its strategic airlift capability and a 120 aircraft procurement is not enough to fulfill the strategic and theater missions concurrently. Acquiring more C-17s is an option and its theater airlift capability should be used to the maximum extent possible, but "borrowing" the C-17 from the strategic flow to accomplish tactical airlift missions is not the complete answer. Theater airlift is too important to be accomplished as a secondary mission. The tactical airlift capability of the C-17 should be used as augmentation to a dedicated theater airlift fleet. This was actually the selling point of the C-17 when it was first conceived--procure a strategic airlifter with tactical airlift capability to augment the existing theater airlift fleets (C-130s and C-141s).

Consequently, only the second and third options resolve the theater airlift shortfall created by the departure of the C-141. However, after closer inspection, the C-130J-30 option is less costly, available now, and better suited to replace the C-141 in its theater airlift role. The C-130E fleet is also in need of replacement having been the tactical airlift "workhorse" as long as the C-141 has been performing both strategic and theater airlift. Thus, the C-130J-30 acquisition will also serve as the new core theater airlifter capable of performing the current C-130 and C-141 tactical missions. An enhanced stretched, aerial refueling capable C-130 is absolutely essential and prevents the theater airlift mission from being overshadowed by focus on the strategic airlift gap.

In less than a decade, the C-141 Starlifter will no longer be in the Air Force inventory, it is time to find the right mix of strategic and theater airlift assets to meet the warfighting requirements. We must remember, airlift has two separate aspects--strategic and theater. The solution is to emphasize both pieces equally in the future. Only then can we meet the airlift requirements of the warfighters.

THE V-22 OSPREY - AMERICA'S AIRPLANE

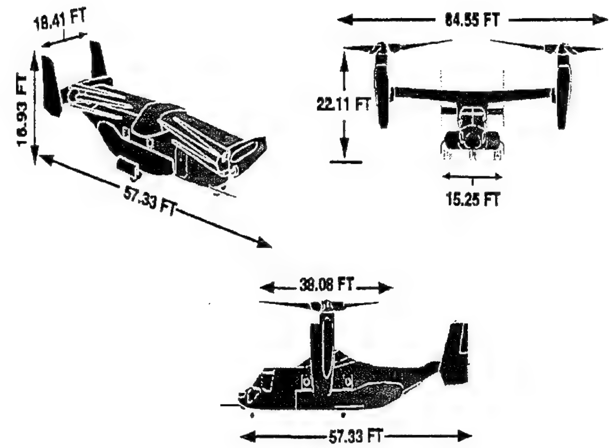
by
Mr. Phillip Rivera
Boeing Defense and Space Group
Hampton, Virginia

What flies like a turboprop airplane faster and farther than today's helicopters, but takes off and lands like a helicopter? It is America's airplane, the V-22 Osprey tiltrotor aircraft.

The system mission for the V-22 is: a medium vertical-lift, assault troop, and cargo transportation carrier for the U.S. Marine Corps; combat search and rescue, fleet logistics support, and special warfare for the U.S. Navy; and long-range transportation of special operations forces for the U.S. Air Force and the U.S. Special Operations Command (USSOCOM).

Background. In April 1982, Boeing Helicopters teamed with Bell Helicopter Textron, and by April 1983, the Bell-Boeing Team started work on a $205M, 2 1/2-year, preliminary design contract. Full Scale Development (FSD) was started in June 1985. In May 1986, the Team received a $1.82B FSD contract to design, build, and test six flight test aircraft plus three other test articles. In February 1989, the government authorized long-lead procurement for the pilot production lot. First flight of the FSD aircraft was 19 March 1989. Although the Secretary of Defense tried to cancel the program every year from 1989 to 1992, Congress restored funding each year. The Team received a $550M contract on 22 October 1992 to start the Engineering, Manufacturing, and Development (EMD) program, and signed a $2.65M definitized EMD contract on 3 May 1994; $2.02B has been appropriated from FY 92 thru FY 95, and $763M was appropriated in the

FY 96 budget for long-lead items in support of the low-rate initial production that starts in FY 97. Coincident with the EMD contract award, the V-22 FSD contract was terminated, and all FSD assets were transferred to the EMD program. The EMD program will yield four production representative aircraft for operational test.



System Description of the V-22. The V-22 Osprey is a tiltrotor aircraft that carries 24 combat equipped troops, up to 20,000 pounds of internal cargo, or 15,000 pounds of external cargo--including the high-mobility multipurpose wheeled vehicle (HMMWV). It can take off and land like a helicopter, but once airborne, it converts to a turboprop airplane capable of high-speed, high altitude flight.

Physical Characteristics of the V-22 Osprey

Rotor Diameter (each)	38.08 ft	Width	84.55 ft (rotors spread)
Fuselage Length	57.33 ft		18.41 ft (wing folded)
Height	22.11 ft	Max. Weight	60,500 lb
Cruising Speed	250 knots (SL) 300+ knots @ 16,000 ft	Empty Weight	31,140 lb
Range	2,100 nautical miles	Cockpit Crew	2
Passenger Seats	25		
Powerplant	2 Allison T406-AD-400 Engines		

There are a number of reasons on why tiltrotor technology is important to America, but I will outline the 10 best good reasons.

The V-22 is a Multi-Service, Multimission Aircraft

Marines are buyig 425 aircraft to be utilized for:

Amphibious Assault
Pre-Position Operations
Self-Deployment
External Carriage of Equipment
Sustained Land Operations
Contingency Operations
24-Troop, 200 NM Radius of Action

"After rigorous technical and cost and operational effectiveness assessments during 1994, 1995 has been a year of continued success in developmental testing (of the V-22). The Osprey fits indelibly into the strategy of forward...from the sea and operational maneuver from the sea, and completes the naval expeditionary force mobility triad. The MV-22, the Advanced Amphibious Assault Vehicle and the Landing Craft Air Cushion cement the Navy-Marine Corps team into a powerful, flexible, and lethal force designed and structured for forward-deployed crisis response in today's dangerous world."

BGen Robert Magnus
Assistant Deputy Chief of Staff for Aviation
Headquarters, United States Marine Corps

Air Force is buying 50 V22s for:

Long Range Special Operations
A-Team Insertion/Extraction to 500 NM Radius of Action
Self-Deployment

Navy is getting 48 Osprey's for:

- Combat Search and Rescue to 480 NM Radius of Action
- Self-Deployment
- Logistics Resupply to Ships at Sea
- Special Warfare Team Insertion/Extraction

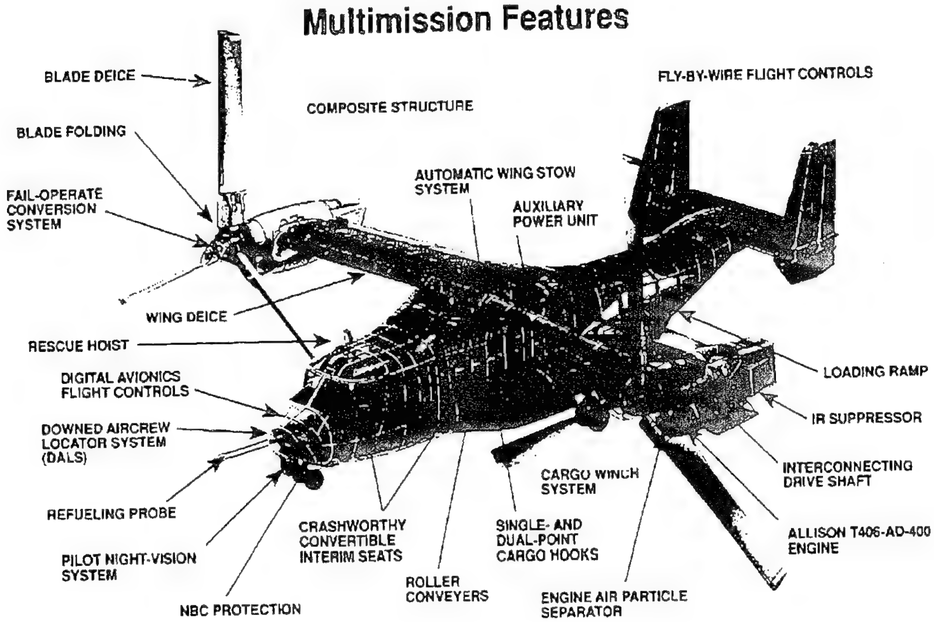
All Services

- Night/All-Weather Capability
- Worldwide Self-Deployment
- Reduced Operations and Support Costs
- Operations in Contaminated Environment
- Advanced Survivability Features

Potential Applications

- Aeromedical Evacuation
- Airborne Early Warning
- Aerial Tanker
- Long-Range Combat Logistics Support
- Antisubmarine Warfare

Multimission Features



Tiltrotor Technology Maturity

The U.S. Government and Industry have invested almost four decades and billions of dollars developing and perfecting tiltrotor technology.

- XV-3 Demonstrated Concept Feasibility - 1950's and 60's
- XV-15 Demonstrated Technology Maturity - 1970's
- V-22 FSD Demonstrated Tiltrotor Capability and Mission Suitability - 1980's
- V-22 EMD Demonstrated Producibility and Affordability - 1990's

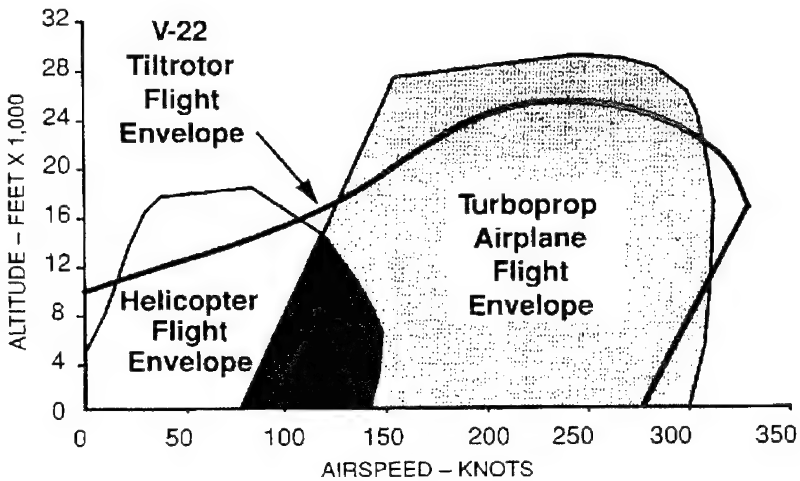
Technical Accomplishments

- The Maturity of Tiltrotor Technology
- The Mission Capability of the V-22
- The Operational Suitability of Tiltrotors

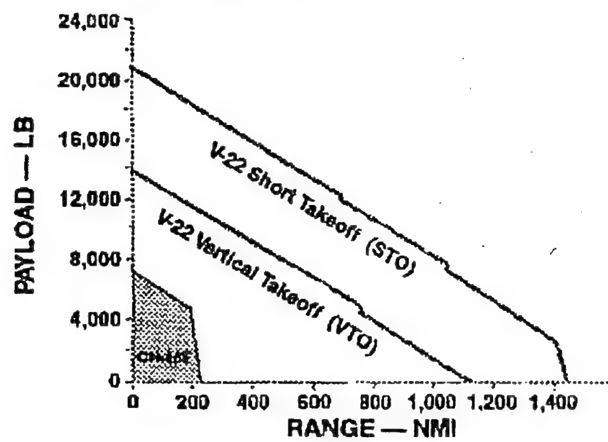
To date, over 940 flights and 1100 flight hours have been accomplished in the flight test program. The maturity of the V-22's tiltrotor technology has met or exceeded the Marine Corps' tactical mission flight conditions.

The V-22 Is More Capable Than Helicopters

Performance



TWICE AS FAST AS A HELICOPTER



Speed, when coupled with the V-22's superior range and payload, yields a significant increase in productivity.

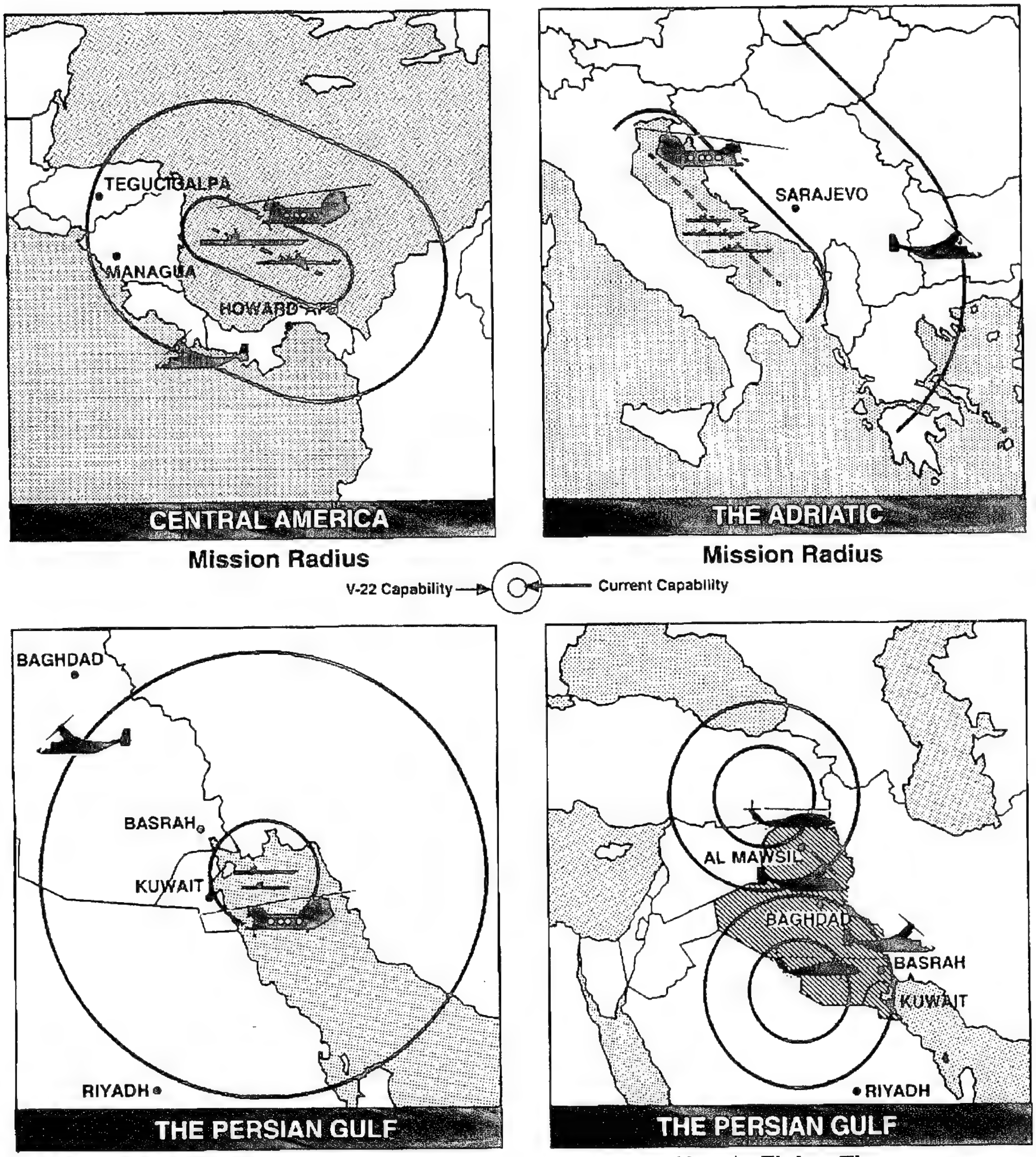
Three times more payload.
Five times more range.

Self-Deployable Worldwide

The V-22 can self-deploy anywhere in the world within days without the need for strategic airlift or sealift.

Tactical Mobility in the 21st Century

Helicopters vs. V-22



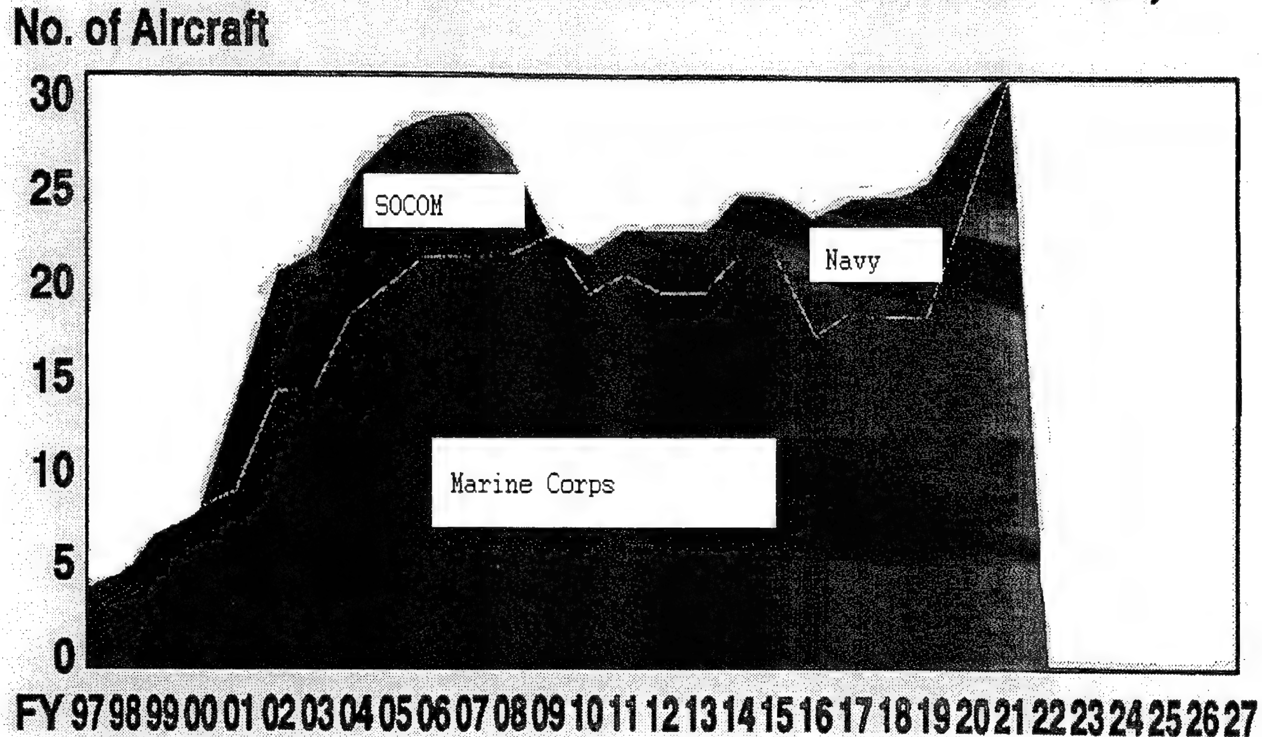
Only the V-22 Has the Speed, Range, and VTOL Capability To Provide the Tactical Mobility Needed for the 21st Century.

Most Cost Effective Alternative

Six separate COEAs and 18 different effectiveness analyses over the past 15 years (by independent agencies) has proven time and again that the V-22 is the most cost and operationally efficient alternative to meet multi-Service needs.

Proposed V-22 Production Profile

($1B PER YEAR PRODUCTION FUNDING CAP)



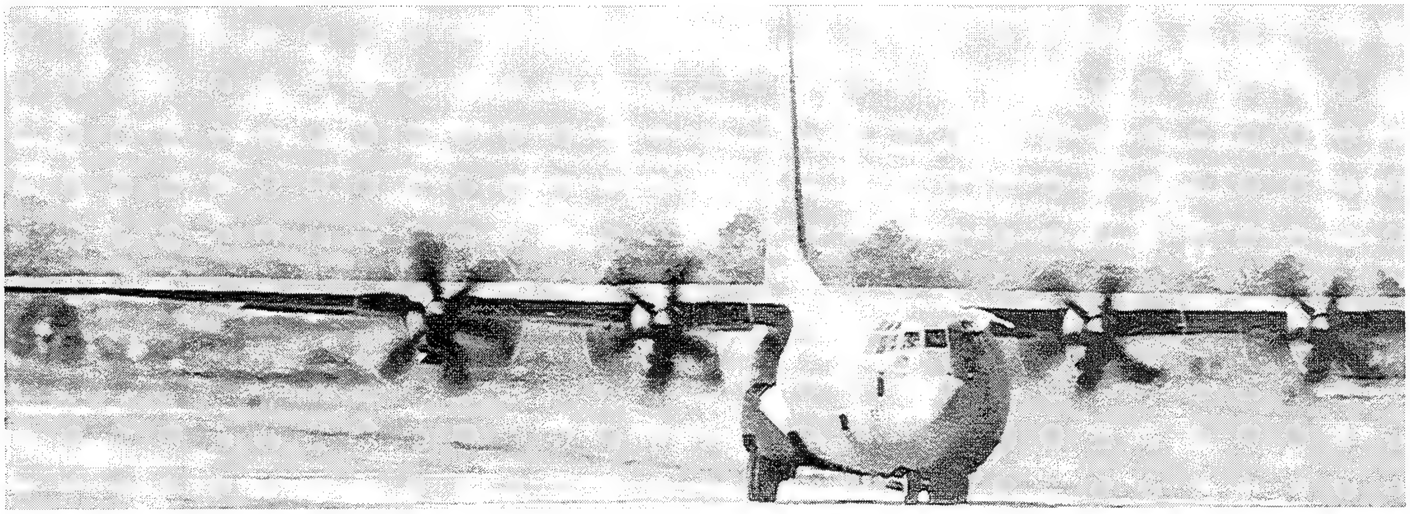
																									TOTAL
MV	4	5	7	8	9	14	14	18	20	21	21	21	22	19	20	19	19	21	21	17	18	18	18	21	30	425
HV														2	2	3	3	3	3	6	6	6	7	7		48
CV					4	6	7	7	7	7	7	5														50
TOTAL	4	5	7	8	13	20	21	25	27	28	28	26	22	21	22	22	22	24	24	23	24	24	25	28	30	523

Conclusion

The fight for the V-22 has taken 15 years, and has been led by the present and past leadership of the Marine Corps and Navy. With the hearty support of Congress the tough years of facing cancellation are now behind us and the Bell-Boeing/Government Team can get on with the business of building a truly technological machine for the 21st century, the V-22 Osprey.

THE C-130J PROVIDES INCREASED OPERATIONAL CAPABILITIES

by
Col Steve Tomhave, USAF (Ret.)
Lockheed Martin Aeronautical Systems
Marietta, Georgia

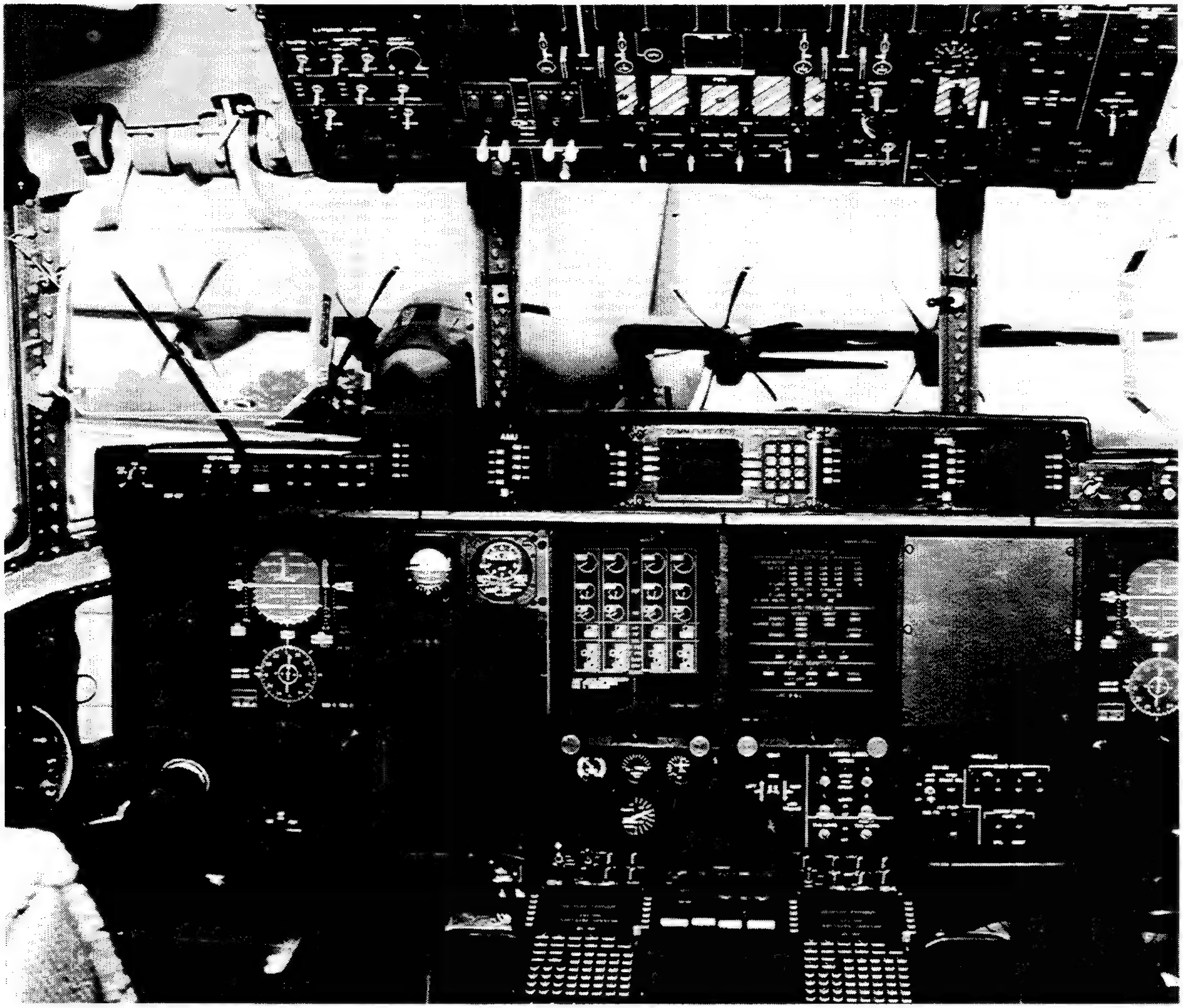


After more than 4 decades, the C-130 Hercules remains the primary choice for operators around the world as the tactical airlift workhorse. It's been involved in every conceivable mission from dropping bombs, to offloading fuel as a tanker, to airlifting combat essential and humanitarian cargo. The Hercules has done it all. Lockheed Martin expects the next generation Hercules, the C-130J, to continue the aircrafts respected heritage into the 21st century. New digital technology, a new propulsion system, increased operational capabilities, and enhanced cargo compartment features provide the capability for improved cargo loadability, airdrop effectiveness, and airland enhancements.

The new C-130J touts new digital avionics tied into the flexible and cost effective 1553B data bus architecture. The state-of-the-art flight instrumentation, redesigned center console and overhead panels reduce the flight crew requirement to two pilots. Dual mission computers with significant growth capability control all major systems and are the heart of the integrated digital technology. The health of every aircraft system is monitored by the Advisory, Caution, and Warning System (ACAWS) which provides both aural and visual indications in the event of component failure. It also provides fault data to the mission computer for downloading at a later time for maintenance and troubleshooting purposes. Dual Honeywell INS/GPS systems provide the precise, worldwide navigation needs of the new aircraft by feeding the digital autopilot and flight director systems. The new communication, navigation, identification management system allows the pilots to control all aspects of the mission from easily accessed control panels, either on the center console or top of the instrument panel. As many as 40 flight plans can be entered into the system for use when necessary.

A new pilot's Head-Up Display (HUD) by Flight Dynamics will be certified by the FAA as a **primary** flight display. It will also permit to CAT III A/B approach minimums. The information presented on the HUD conforms to all military symbology MILSTDs and promises to be a significant workload reducer for the pilots. Easy transition from visual to instrument or instrument to visual weather conditions will aid the pilots in maintaining situational awareness during critical flight segments, alleviating the necessity of referring to head-down displays for instrumented information. This is especially helpful in rapidly changing situations and low altitude operations. The HUD can also display course guidance to a Computed Air Release Point (CARP) as well as a mission computer generated glide path vector reduced landing dispersion. Future growth in the HUD system will

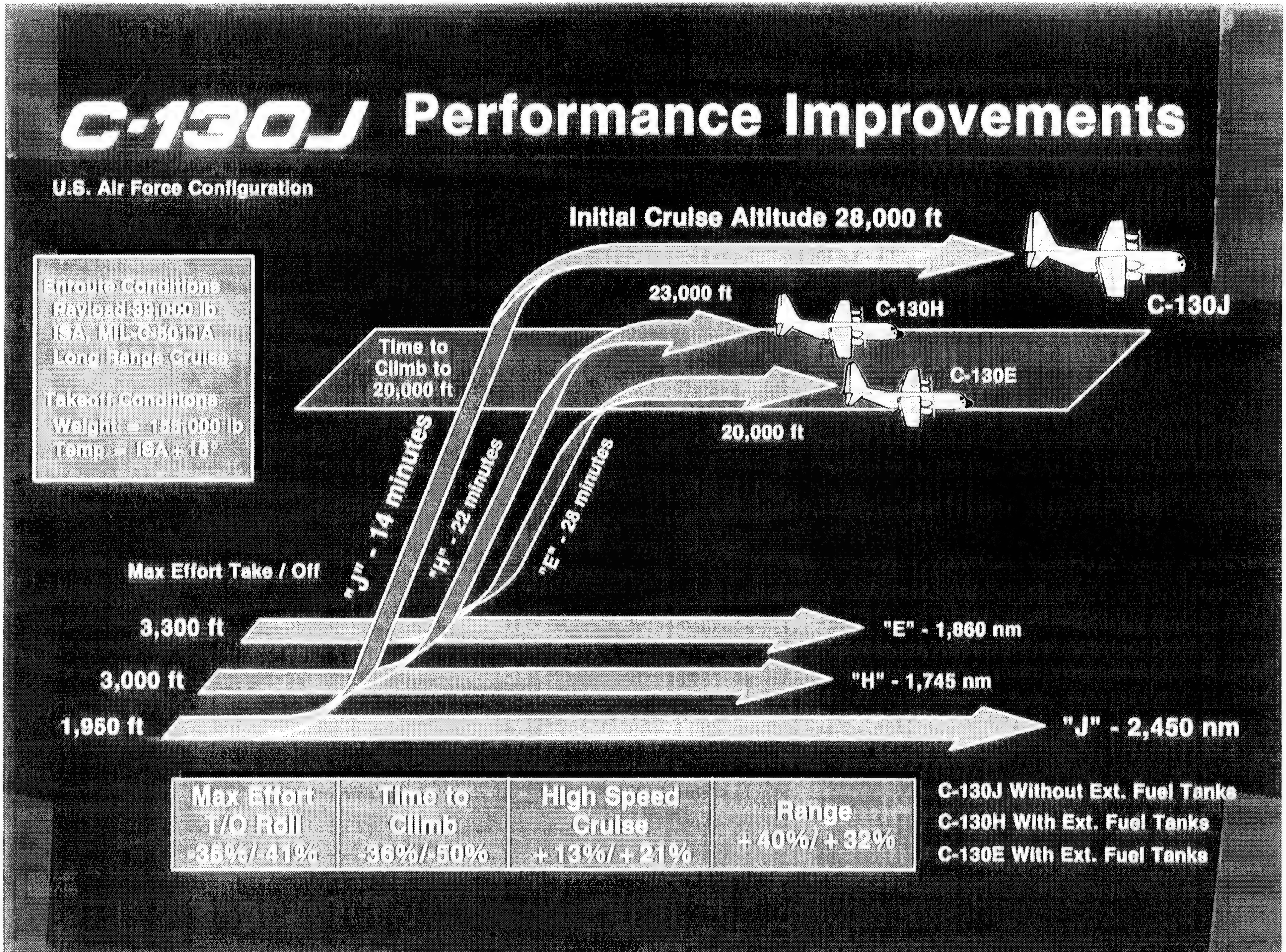
permit rastor displays from video sources such as Forward Looking Infrared (FLIR)/Millimeter Wave (MMW) imagery for enhancement of autonomous landing guidance.



The heart of the C-130J's advanced technology is its modern flight station with Liquid Crystal Display (LCD) instrumentation.

While the HUD systems provide the pilot with a continual outside the cockpit reference, the head-down displays or color multi-functional display units (CMDU) provide both a primary and secondary source of flight and navigational information. The CMDUs are liquid crystal display instruments capable of displaying any of several formats including the primary flight display, color radar, ACAWS, digital map display, propulsion, and other aircraft system display and station keeping information. An added bonus allows the CMDUs to overlay one display over another such as weather radar display over the digital map routing.

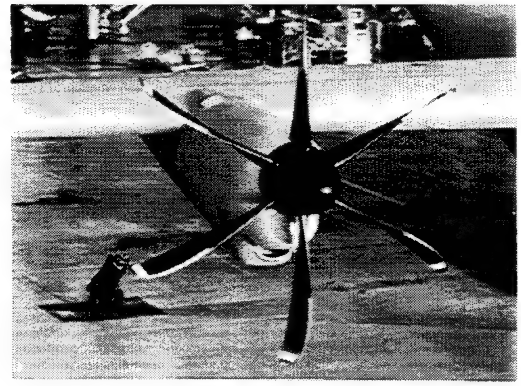
The new intra-formation positioning system or station keeping system is the SKE 2000 by Sierra Research. The SKE 2000 is completely integrated with the aircraft communication, navigation, identification management system (CNI-MS), the HUD system and mission computers. Mean time between failure on the new SKE 2000 has increased markedly. In addition, the system is compatible with the C-17 and older


C-130J Performance Improvements
U.S. Air Force Configuration
Enroute Conditions
Payload 39,000 lb
ISA, MIL-C-5011A
Long Range Cruise
Takeoff Conditions
Weight = 155,000 lb
Temp = ISA + 15°
Initial Cruise Altitude 28,000 ft
23,000 ft
C-130H
C-130J
Time to Climb to 20,000 ft
C-130E
20,000 ft
"J" - 14 minutes
"H" - 22 minutes
"E" - 28 minutes
Max Effort Take / Off
3,300 ft
3,000 ft
1,950 ft
"E" - 1,860 nm
"H" - 1,745 nm
"J" - 2,450 nm
Max Effort T/O Roll -35%/-41%
Time to Climb -36%/-50%
High Speed Cruise +13%/+21%
Range +40%/+32%
C-130J Without Ext. Fuel Tanks
C-130H With Ext. Fuel Tanks
C-130E With Ext. Fuel Tanks

Hercules models. There are a multitude of growth capabilities in this system as well. Among them are low probability of detection, low probability of intercept modes and anti-jam capability, high speed datalink capability, collision avoidance guidance with command steering, and 3-D coupling of the autopilot and autothrottle systems.

In order to take full advantage of the navigational growth capabilities of the aircraft, provisions are being made to include an integrated precision radar approach system as an alternative to the microwave landing system previously projected for the aircraft. This low cost alternative will provide CAT II approach accuracy and wide coverage curved path guidance. It is a fully automated system capable of full coupling to the autopilot and autothrottle systems. Most importantly, the system uses minimum ground equipment (beacon) with minimum alignment time. New systems assisting the pilot from within the aircraft include the combination of the new Allison 2100D3 engines and the Dowty six-bladed composite propellers which allow higher airspeed, increased power for takeoffs and improved fuel efficiency. Operationally, the C-130J offers almost 30 percent increase in power, 30 knots in airspeed, reduced drag, and 15 percent in fuel economy extending its range over the current E-model by nearly 40 percent without using external fuel tanks. Inherent within those advantages are a 40 percent decrease in max effort or normal takeoff distances and a 50 percent decrease in time to climb to optimum altitude. In addition to those features, the engine and propeller operation is controlled and managed by the Full Authority Digital Electronic Control (FADEC) allowing a single engine control lever. (For all you C-130 pilots, that means no more condition levers.) The FADEC gives you precise speed selection and accurate synchrophasing with the power lever electronically linked to the pitch control unit.

The Dowty propeller system is a proven system having already been used on several aircraft including the SAAB 2000 passenger aircraft. The C-130J propeller system will reduce the number of parts by 50 percent and the weight by more than 1,000 pounds from the current propeller system used on the C-130E/H aircraft. The blades are made of composite materials including carbon, glass, and polyurethane which effectively reduces weight, increases durability, and facilitates field repair.



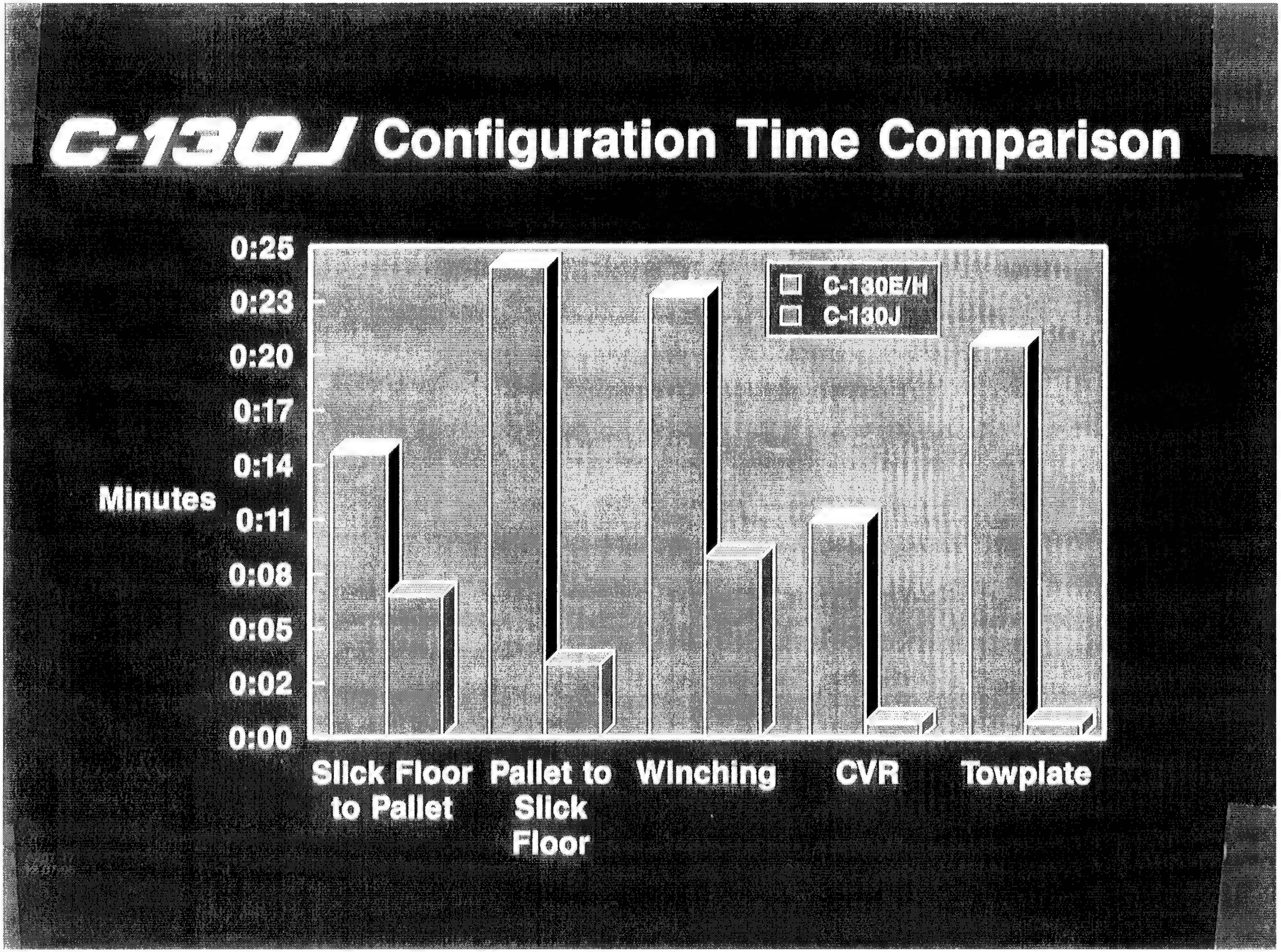
DOWTY PROPELLER SYSTEM

As with the C-130H, the C-130J comes in a stretched (15 feet longer) model option--the C-130J-30. The additional 15 feet of length is all in usable cargo compartment space, especially effective since many C-130 loads are "cubed out" (out of space) before they "gross out" (use up weight carrying capability). The C-130J-30 costs the same to operate as the C-130J while featuring identical outstanding performance. The J-30's increased cargo compartment length yields great returns in volumetric payload characteristics when compared to the C-130J.

	C-130J	C-130J-30
Paratroopers	64	92
Ground troops	92	128
463L pallets		8
Airdrop platform length (ft)	40	55

As you can see, the J-30 offers a huge advantage when deploying an airborne or light unit. As an example, the 82d Airborne Division's medium sized Brigade airdrop option requires 110 standard C-130 loads which can be accommodated with only 78 C-130J-30 loads. The United Kingdom and Australia have both ordered the new C-130J-30 aircraft.

Other optional, operational features can extend the range and increase the flexibility of the C-130J/J-30 considerably. As an example, the Royal Air Force C-130J-30 aircraft will include the Marshall Aerospace inflight refueling (IFR) probe and associated plumbing. The baseline C-130J aircraft includes a strengthened cab top to facilitate a post-production installation of a customer-option inflight refueling probe. Additionally, the aircraft can be modified to a tanker configuration based on other baseline aircraft provisions.


C-130J Configuration Time Comparison
C-130E/H
C-130J
Minutes
0:25
0:23
0:20
0:17
0:14
0:11
0:08
0:05
0:02
0:00
Slick Floor to Pallet
Pallet to Slick Floor
Winching
CVR
Towplate

In addition to the above operational benefits, the C-130J/J-30 allows value added features of increased mission capable rate and markedly reduced maintenance man-hours per flight hour (MMH/FH). Reliability and maintainability projections decrease the MMH/FH by approximately 50 percent when compared to the E-model. A good example of the new technology already fielded is the Westinghouse Low Power Color Radar (LPCR) or AN/APN-241 which is presently in operation on the newest USAF C-130Hs (H-3). The old APN-59 mean time between failure (MTBF) rate is a sad story. You "navs" and "maintainers" can attest to that. The LPCR guaranteed MTBF is 1,000 hours. New components and modifications incorporated within the new C-130J are all put under the microscope for similar savings and guarantees. Overall, Lockheed Martin expects the C-130J operations and support costs to be reduced nearly 35 percent over the C-130E.

Just an aside on the AN/APN-241 radar. When the high resolution ground mapping capability of the APN-241 is coupled with the dual INS/GPS and digital map systems, the C-130J provides single ship or formation all weather aerial delivery capability which is a significant improvement over the current antiquated All Weather Aerial Delivery System (AWADS). Evolving technologies such as the Light Detection and Ranging (LIDAR) that can map wind gradients from flight altitude to the drop zone and provide real time mean effective wind for CARP updates, could further enhance C-130J airdrop accuracies in the future.

There are a number of research and development studies currently in progress on the new J-model at Lockheed Martin. These include efforts to increase maximum zero fuel weight payloads and airdrop load weights. Payload improvement will greatly increase aircraft flexibility and overall operational utility.

What about the cargo compartment enhancements? The loadmasters have been chomping at the bit for years to upgrade the rear of the aircraft to reduce their workload and permit easier cargo loading and offloading, reducing aircraft turnaround time, and reconfiguration time. One recommendation was to incorporate an easier and standardized airdrop extraction system. Let's take a look at some of the improvements in the rear of the C-130J that make it more user friendly and operationally palatable.

The first and most noticeable enhancement to the cargo compartment is the integral and in-place equipment. Enhancements consist of new roller conveyor trays/coves in the cargo floor for stowing roller conveyors when using a bare cargo floor. The coves run the entire length of the cargo floor including the ramp. Quick stow time means less overall time in converting to a slick floor configuration or vice versa. One loadmaster can reconfigure the aircraft in 7 minutes to install the rollers to accommodate pallets or platforms. What loadmaster wouldn't appreciate a significant reduction in the reconfiguration time? The time to reconfigure from pallets to slick floor takes only 3 minutes versus the previous 25 minutes. The in-place roller trays/coves also mean true roller accuracy minimizing pallet drag forces and improving Container Delivery System (CDS) bundle tracking during airdrop.

Along with these enhancements, try the improvements to winch operations on for size. Lugging and chaining down the winch in the C-130E/H is a major headache: plus it was always in the way. A 24-minute rigging job is now down to simply reeling out the winch cable at 40 feet per minute. The winch is now an integral part of the aircraft and is stowed beneath the cargo compartment floor near the Fuselage Station 245 bulkhead. The winch is a Lucas-made unit capable of 5-40 feet per minute speeds at full power and is smaller in size than the present winch. The unit has a 6,500 pound capacity and functions similarly to the C-5 or C-17 winch. The winch accessory package includes two snatch blocks and a whiffletree assembly for double line pull or off-center winching operations.

Four separate modifications provide significant improvement for airdrop operation. The first modification is the CDS center rail system which provides center vertical restraint (CVR) during CDS airdrops. The CVR system rotates 90 degrees from its stowed position in the cargo floor to provide a restraint system for the CDS skid boards. The CVR provides single or double stick capability for full CDS or CDS/paratrooper airdrops. The six sections are deployed rear to front and stowed front to rear. The second modification is the integral drogue chute towplate for airdrop extraction. Electrically operated mechanisms allow the drogue chute to be deployed and released. Deployment of the extraction chute and then transfer of force by actuation of the towplate mechanism provides a crisp and accurate extraction of the airdrop load. The integral mounting requires no reconfiguration time for missions requiring towplate usage. Third, the new J-model has a 250 knot cargo ramp/door capability for high speed ingress/egress

during airdrop scenarios. Fourth, the Aerial Delivery System ramp support arms can remain connected for airdrop, straight in-loading and ground offload. This is a major safety improvement and saves configuration time.

The final major improvement to the cargo compartment is the integral, electric lock system. The new system is a Lockheed Martin design manufactured by CEF Industries. The locks are electrically activated and computer controlled from a loadmaster control console or additional individual lock controller units installed on the cargo sidewalls. The locks are load-sensing and provide the required restraint depending upon the load weight and extraction parachute. This is especially important during heavy equipment airdrops. For you loadmasters, this means no more mechanically adjusting the right-hand locks for the heaviest platform weight during your rigging checklist. The lock release settings are programmed on the loadmaster control panel according to expected aerial delivery conditions. The simultaneous release of all locks enhances the accuracy of the airdrop. You can also selectively release loads for airdrops on subsequent drop zones on the same airdrop mission. The electric locks are a consolidated part of the low profile rail system which provides an additional one and one-eighth inches for higher profile loads--a significant advantage in loading some of the U.S. Army's equipment today. An additional benefit from the low profile rails is the reduced shoring requirement.

This is the C-130J--a distinct improvement over the present day Herc--not only from a pilot's perspective but from the loadmaster's as well, and the Army user! The improvements and modifications included in the new C-130J will be put to the test during the ongoing flight test phase, before the USAF takes possession of its first two aircraft in early 1997. No doubt the new generation will continue the respected heritage of previous generations.

Biography

Steve Tomhave is a former C-130 pilot. During his career in the Air Force he logged 4,500 hours flying time in the Hercules. A considerable portion of those hours were logged during combat missions in Southeast Asia flying earlier model C-130s. He is a graduate of the University of Missouri (BS in Political Science), University of Arkansas (MS in Operations Management), The Air War College, The Army War College, and the Army Command General Staff College. Tomhave now serves as a marketing support specialist for Lockheed Martin Aeronautical Systems, manufacturer of the C-130J.

TOTAL ASSET VISIBILITY - FROM THEORY TO REALITY

by
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Fayetteville, NC

Haiti: Total Asset Visibility In Action

Port-au-Prince, Haiti. During logistics operations conducted in support of Operation Restore/Uphold Democracy, Radio Frequency (RF) tags and fixed- and held-hand interrogators were used successfully to rapidly identify critical assets. The Army deployed fixed interrogators at critical choke points between continental United States supply depots and Haiti, including depot dispatch offices, airports, and transportation points. At the depots, specialists affixed 8-kilobyte RF tags to air pallets destined for Haiti. Each tag was loaded with 80 bytes of transportation information that fixed interrogators at each choke point could "read." The interrogators passed the data on the tags by telephone lines or satellite to a central computer database. Commanders and logisticians were then able to access this database, called INTRANSIT, which is located at the Volpe National Transportation Systems Center in Cambridge, Mass. Logisticians used the database to monitor the movement and identify the arrival time and location of each shipment. The technology was rated a great success and provided a powerful new tool for the Army and Department of Defense (DoD) to use in

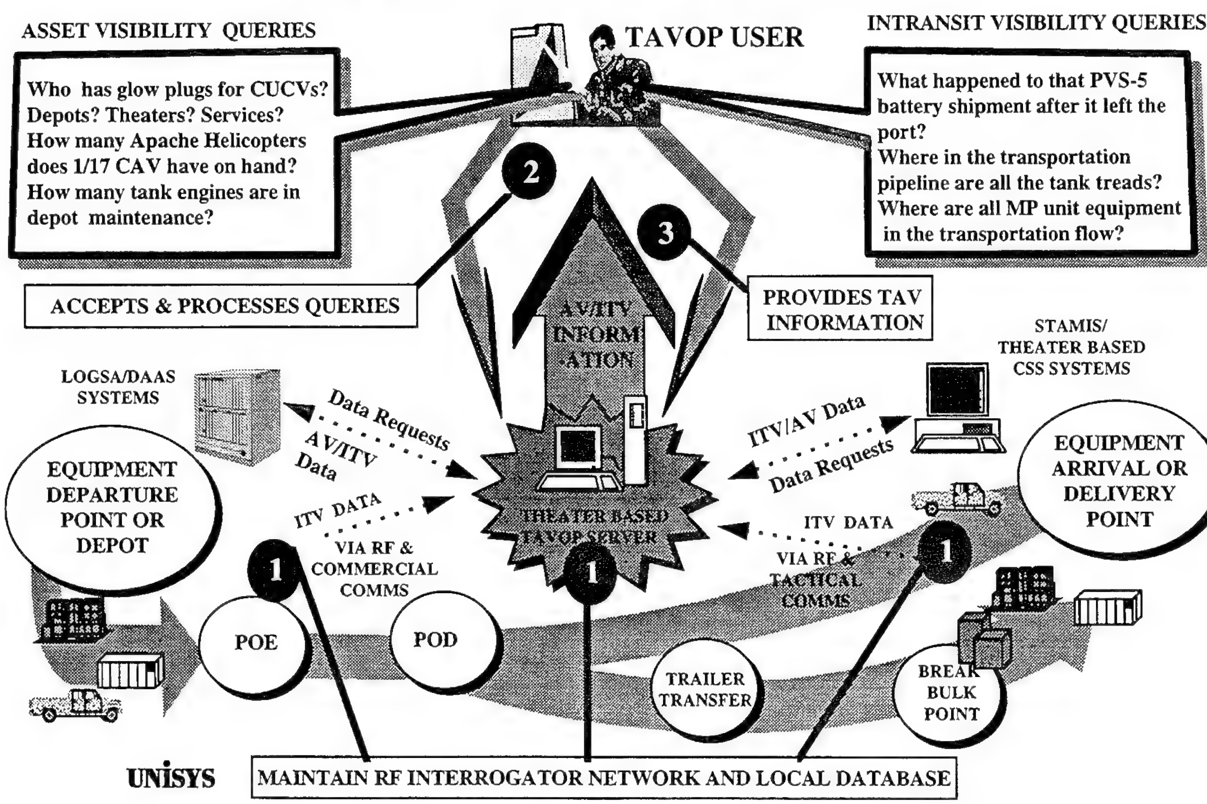
gaining total asset visibility over their distribution systems.

Total Asset Visibility Operational Prototype-TAVOP

The scenario cited above illustrates a "real world" application of a U.S. Army project called Total Asset Visibility Operational Prototype (TAVOP). This project involves the integration of new Automatic Identification Technology (AIT), such as RF tags, into existing logistics procedures/systems in order to increase Total Asset Visibility/In-Transit Visibility (TAV/ITV) of critical assets. The project is sponsored by the U.S. Army Logistics Integration Agency (LIA). The TAVOP Team consists of Unisys, PRC, GTE, and SRC. Key components of the TAVOP concept include:

- A one-stop source to answer Asset Visibility/In-Transit Visibility questions.
- A relational database which will support the collection, storage, and access of in-theater logistics information.
- Automation of source data via use of Radio Frequency Identification (RF/ID) technology and other AIT, i.e., Optical LASER Cards.
- On-demand information to support staff research and generate ad hoc reports.
- An exchange of data via wide area communications with in-theater Standard Army Management Information Systems (STAMIS).

TAVOP FUNCTIONALITY



What Is Total Asset Visibility/In-Transit Visibility?

The draft DoD TAV Implementation Plan defines Total Asset Visibility as follows:

"TAV is the capability to provide users with timely and accurate information on the location, movement, status, and identity of units, personnel, equipment, and supplies. It also includes the capability to act upon that information to improve the overall performance of DoD's logistics practices."

TAVOP can be broken down into two key components: Asset Visibility (AV) and In-Transit Visibility (ITV). AV provides information categorized as In-Use, In-Storage, or In-Process. In-Use Visibility

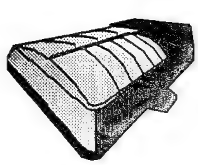
provides information on organic unit equipment with a view towards unit readiness. In-Storage Visibility provides information on all stock controlled by a Supply Support Activity (SSA), such as pre-positioned war stocks, or warehouse supplies. In-Process Visibility provides information on equipment and repairables in maintenance. ITV, on the other hand, provides "inside-the-box" information on container contents and information on materiel or personnel moving throughout the Department of Defense (DoD)/Army transportation systems.

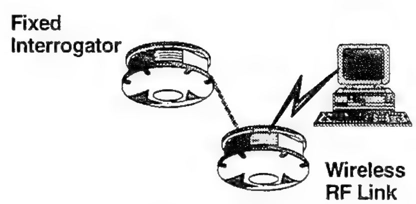
Why Do We Need A TAVOP Capability?

The U.S. Army is using the TAVOP project to address specific AV/ITV issues and deficiencies identified in the DoD Logistics Strategic Plan (LSP), Edition 1994, and the Deputy Chief of Staff for Logistics (DCSLOG) Total Distribution Action Plan (TDAP), dated 8 March 1993. These plans were a part of the Lessons Learned documentation resulting from the Gulf War. The LSP and TDAP specifically identify the lack of TAV, as a paramount problem that DoD and the Army must quickly resolve. In addition, the following deficiencies were identified:

- Many stovepipe solutions exist with limited use.
- Integration hampered by lack of DoD objectives.
- Prototypes integrate at the data level but not functionally.
- User must integrate the data and systems lack open access techniques.
- Open systems with client-server capabilities needed to provide for evolving requirements.
- System integrator must provide single view of all systems and data - source data integration.

AUTOMATIC IDENTIFICATION TECHNOLOGY (AIT)





RADIO FREQUENCY (RF) TAG

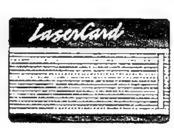
- Combination Computer Controller, 2-way Radio
- 128 KB Capacity
- Affixed to Containers, End Items Other Items

FIXED/HANDHELD INTERROGATORS

- Capability for Multiple RF Tag ID, Read/ Write/Edit Data, and Ad Hoc Query
- Handheld Provides Mobility in Non-Fixed Sites
- Fixed can be Linked to Wireless, Satellite, WANS

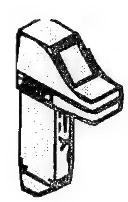
OPTICAL LASER CARDS

- Credit-Card Size
- Store up to 1200 Pages of Data
- Card Reader/Writer used for WORM Capability



BAR CODE READERS

- Fixed or Handheld
- Capability for Data Storage & Transfer Via RF
- Interface with RF Tags & Laser Cards



UNISYS

TAVOP Technology

The Total Asset Visibility Operational Prototype project involves the use of leading edge Automatic Identification Technologies. These technologies include the following:

Radio Frequency (RF) TAGs. The identification tags are electronic devices approximately 6"x8"x2" that contain a receiver/transmitter and storage medium. When queried by an interrogator, the tag transmits the stored data to the interrogator using radio frequency signals. The device has an integral power source and antenna. It is ruggedized to withstand severe environmental conditions, has a non-rechargeable Lithium battery with 400 milli-amp hours capacity, and an industrial adhesive backing to affix them to cargo. The tags communicate at 433.2 Mhz and at power levels less than 20 microwatts. When applied to materiel, the tags provide omnidirectional read/write capabilities and report sequentially when queried by fixed or hand-held interrogators.

Fixed/Hand-held Interrogators. The interrogators provide the ability to read and write data directly from or to the RF tag. These interrogators may be either hand-held or fixed.

Hand-held Interrogator (HHI). This is a one man-portable device. It provides local visibility, allowing the soldier to display the data of a tag without physical contact. The HHI can store in memory up to 512 Kbytes, which equates to the contents of 4 RF tags. The HHI can also modify and write data to tags, provide a scrolling display, and has an RS-232 serial port for transferring data to other devices, such as microcomputers or bar code readers. These interrogators can also "collect" and "read" tags: "collect" reads only the tag identification number, while a "read" retrieves the tag's full data content.

Fixed Interrogator. The typical fixed interrogator has an average range of 300 feet. These interrogators require 110 vac/6vdc power, and generally work best when installed at a height well above the RF tag, such as at the top of a utility pole or building, and can also be mounted on a vehicle. The concepts of "collect" and "read" as described above, also apply to the fixed interrogator. Fixed interrogators can interact with other logistics applications directly via cable or wireless devices. In addition, the interrogators can be linked with various satellite and land-based telephone communications systems in order to provide long-range, even worldwide visibility.

Optical LASER Cards. This is a credit card sized storage medium, in a Write Once Read Many (WORM) format similar to a compact disk. It has the capacity to store approximately 1200 typewritten pages of data. Information is stored digitally on the card in a binary code. Virtually any information that can be digitized can be stored on a laser card. The card has a nonvolatile and environmentally tolerant memory, and is impervious to magnetic or electrostatic fields. The card can be continuously updated with new information and is nonerasable. Use of this card requires a laser card reader/writer. This is a device utilized to add data to or retrieve data from a laser card. Normally such a device has the capability to "read" 5000 characters/second and "write" about one-half that amount. The device is capable of interfacing with both DOS and UNIX-based systems.

BAR Code Readers. These are devices that provide the capability to read bar codes and store the read information. They can also transfer that information via Radio Frequency tags as well as laser card. The devices may be either fixed or hand-held.

TAVOP Scenarios

With a TAVOP capability established in a Theater of Operations, the following are typical scenarios for its use in logistics operations.

Supply Request. Currently in the Army, when an item is not available for immediate issue from the supporting Supply Support Activity (SSA) warehouse, a requisition is placed into the supply Standard Army Management Information System (STAMIS) and the user normally waits from one to seven days or more, to receive supply status. With AIT integration, the user will be able to track the requisition status through an in-theater relational database. The user will be able to query the TAVOP relational database which will receive status input directly from the supply and transportation systems.

Transportation. When an SSA or depot releases the item for issue, the ITV portion of TAV begins. An RF tag holding data for all shipment units in the container, will be placed on each container or trailer. SSAs and depots will use the Automated Manifest System (AMS) to provide laser cards with appropriate Military Standard Requisitioning and Issue Procedures

(MILSTRIP) data for each multipack of major item in the shipment. As the shipment goes through the various transportation nodes, RF interrogators will update the ITV database, and the location of the shipment. Transportation nodes include, but are not limited to: the shipper, Aerial/Water Port of Embarkation (A/WPOE), Aerial/Water Port of Debarkation (A/WPOD), hub distribution points, and an SSA. The in-theater TAVOP relational database will provide, via the Internet/World-Wide We or other communications medium, status to the users requesting information on the particular item.

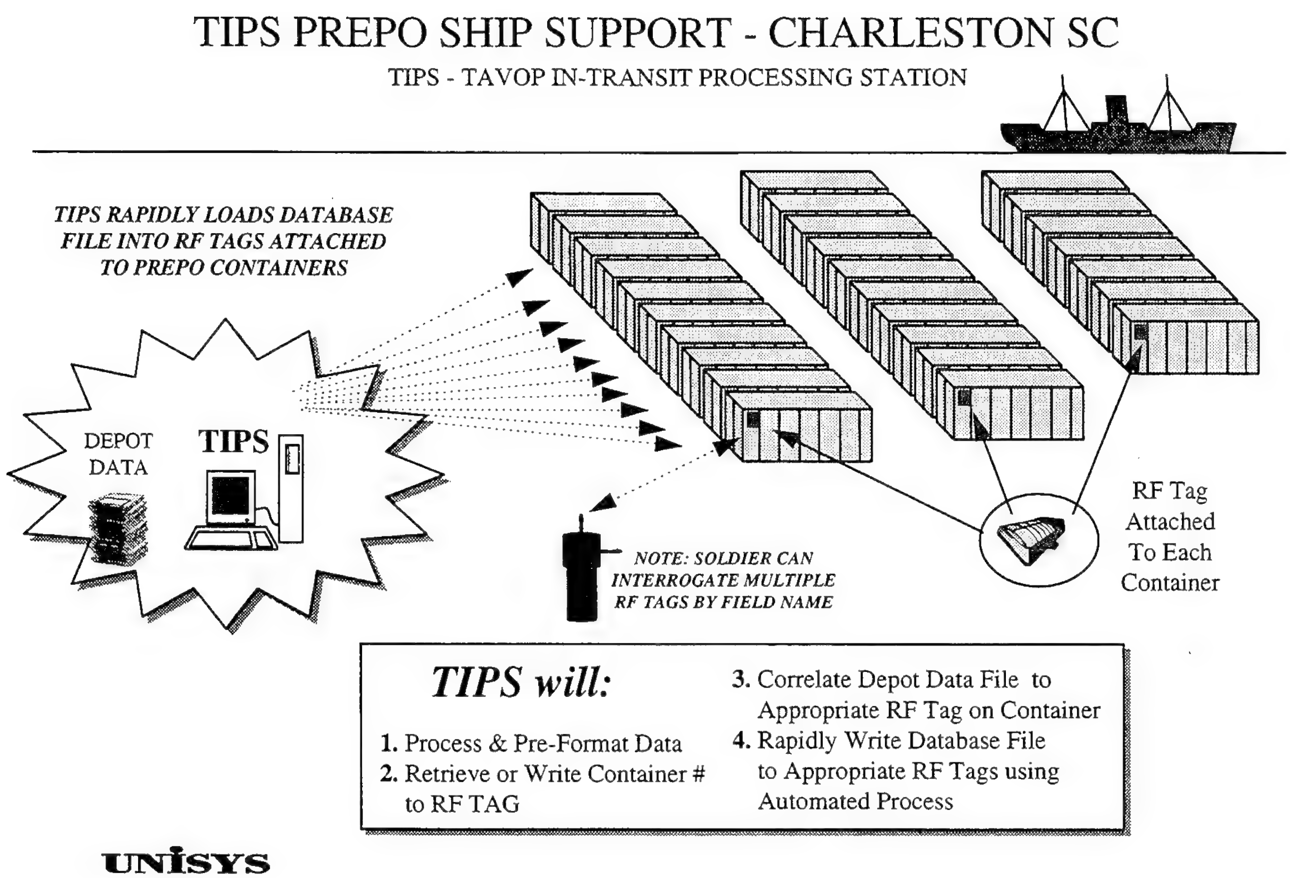
Supply Receipt. When the SSA receives the shipment, warehousemen will be able to check the contents by interrogating the RF tag on the container itself or open the container and use the AMS laser card(s) on the pallets or shipment units. Either method will provide data to input to the supply STAMIS. To confirm the items are in the shipment, warehousemen use bar code readers on each item received. The laser card data and the scanned data are compared and accountability is established. If items are not present, a report of discrepancy will be produced automatically for processing. The final supply receipt will close out the status history in TAVOP and it will be retained in the database for 30 days after receipt by the SSA.

Putting TAVOP To The Test

During the past year, TAVOP teams deployed on Radio Frequency (RF) tagging missions for the Army Pre-position Afloat (PREPO) program, the Battlefield Distribution System (BDS) exercises, Drive Around '95 (DA'95) exercise, the Humanitarian Assistance Program (HAP) for Operation Provide Hope, and are providing support for the current Bosnia missions. These missions have been fast-paced and operational in nature in order to quickly permit logisticians to use this revolutionary technology to effectively complete logistics missions.

Although each of the five missions had some unique requirements, the overall concept remained the same--Total Asset Visibility. Whether tracking the distribution of medical supplies for a humanitarian mission or finding a box of Meals Ready to Eat (MREs) in a 2000 container yard, the commonality is knowing where assets are at any given time. The goal of TAV is to identify desired assets, then be able to monitor, track, and locate them at any point in the distribution processes including when the assets have reached their final destination. This goal is achieved through RF technology.

As part of the **Army Pre-position Afloat** mission, in early 1995, Army and Defense Logistics Agency (DLA) supply depots packed support items such as food, medicine, lubricants, barrier materials, common user parts, and a 100-bed hospital into over 2,800 containers and loaded them onto two pre-positioned ships. Once the ships arrive in the contingency area, the receipt process must be able to quickly identify which container has the desired contents. The experience of the Marine Corps in the Gulf War illustrated that pre-positioned ships were a method the Army could use to better support its rapid deployment forces. Early in the conflict, the Marines offloaded pre-positioned ships to give immediate armor and sustainment capability to their forces. In contrast, the Army had a rapid deployment force, the XVIII Airborne Corps, but no rapid sustainment capability. Using TAVOP, in conjunction with pre-positioned ships, helps to provide total assets and in-transit visibility capability, thus ensuring rapid and effective sustainment of the fighting forces.



The U.S. Army Deputy Chief of Staff for Logistics (DCSLOG), along with what was then the Strategic Logistics Agency (SLA), determined that the existing RF tag data format used for containers was not meeting the Army's requirements. The tag format did not allow for users to conduct ad hoc queries of multiple RF tags simultaneously, only one at a time, which was a time-consuming process. They needed a TAV system that supported the intended receiver of thousands of pre-positioned stocks containers--the warfighter. The TAVOP team determined that a reformatting of the tag data into a special database format, created by Savi, the RF tag developers, would allow the warfighter to take full advantage of the database and RF technology capability in the Theater of Operations.

This mission encompassed the first Department of Defense operational application of an ad hoc query capability from a hand-held interrogator to multiple database files located on RF tags. The mission was accomplished successfully with the tagging and loading of over 2800 containers on two pre-position ships, which are currently at sea awaiting to be committed for the next logistics mission, wherever it may be.

With the demonstration of the Army's new **Battlefield Distribution System** concept, the Army had a requirement to monitor, track, and locate supply shipment data from Mechanicsburg (DDSP-M) to battalions in Europe through the use of RF devices. TAVOP assisted the Army and the Department of Transportation in the capture of source data information Military Standard Requisitioning and Issue Procedures/Military Standard Transportation and Management Procedures (MILSTRIP/MILSTAMP) including content data captured from the Distribution Standard System (DSS) computer. The data would then have to be transferred to an RF tag and/or an Automated Manifest System (AMS) card. Once the tag/card has been "loaded," or "burned" as this initial step is commonly called, the AMS cards and RF tags would be affixed to multi-packs and air pallets, respectively, in the loading area of the Defense Distribution Depot Susquehanna PA-Mechanicsburg (DDSP-M) depot through the use of RF tag interrogators installed at strategically located "choke points." The user would then be able to track supplies

from Mechanicsburg to the Sea Port of Embarkation (SPOE) or the Aerial Port of Embarkation (APOE), then on to the point(s) of debarkation and finally to the consignee.

The **Humanitarian Assistance Program** (HAP) is a State Department-sponsored mission that provides destitute cities/countries with the proper medical supplies and assistance. This mission can be viewed as a preventative mission so that disease and infection can be avoided. The medical equipment for these missions is drawn from unit excess. The supplies to support the medical equipment is drawn from eight excess or War Reserve. The handling of the equipment and supplies is not supported by any existing Standard Army Management Information System (STAMIS). The user had a requirement to maintain inventory records for all of these assets, manage the containers, load the containers, and maintain transportation documentation. On the receiving end, the user had a requirement to audit the containers and direct them to the proper hospital unit. There existed no automation support at the receiving site. The State Department requires the user to maintain an inventory list so that the total value of the mission can be determined. The TAVOP team assessed the need for the development of a database program to manage inventory assigned to each of the hospitals. The team also sought to meet the program's need to effectively track the movement of medical supplies/equipment and attain "in the box" visibility by using the Radio Frequency (RF) tags as Automated Identification Technology. RFID equipment was, therefore, installed on three separate medical warehouses in Pirmasens, Germany in September 1995 to meet this requirement. The installation and subsequent operation during Operation Provide Hope served as a successful proof-of-concept demonstration for determining the ability of RFID technology to track logistics support and unit moves associated with medical support to contingency operations.

Drive Around '95 was an interoperability field training exercise (IOX) conducted by Commander, Land Forces-Central (COMLANDCENT). The IOX took place in Mannheim, Germany during 23-27 October 1995, involving personnel from the United States, Belgium, France, Germany, the Netherlands, and the United Kingdom. Logistics personnel and equipment from these nations were to deploy to Mannheim and form an integrated unit under the commander and control of a notional Multinational Joint Logistics Center (MJLC). The MJLC was to support a simulated scenario where a multinational corps is involved in out of area operations. The TAVOP team identified the user's requirement to maintain total asset visibility and in-transit visibility of logistics during this simulation. With troop deployments complete and sustainment operations begun, national stocks would be transported to brigade or division support units in the field. Automated Identification Technology would be used in the asset tracking systems used by the nations.

The general aim for Drive Around '95 was to enhance the standardization of different military and civilian movement and transportation systems by identifying standardization shortfalls and developing recommendations for the way ahead. Specifically, the user had a requirement to enhance the standardization of flatrack and container systems in a multinational environment involving asset tracking systems where possible. To accomplish this, the TAVOP team recommended that the MJLC acquire a file server, establish a choke station, a burn station, and a monitor station, and use RF tags and interrogators as their Automated Identification Technology. Since this exercise coincided with the planned installation of the In-Transit Visibility (ITV) server and the development of the database application and choke stations in Europe, this effort provided an excellent catalyst and aided considerably in TAVOP developmental efforts. Additionally, there was a requirement to establish a "real time" electronic data interchange between its ITV server and the CONUS-based Defense Transportation Tracking System (DTTS). DTTS is a Global Positioning System (GPS) and cellular message-based system that tracks "real time" movement of sensitive cargo. Using the TAVOP prototype helped the COMLANDCENT identify standardization deficiencies in the field of flatrack and container model operations, and finally formulate further standardization requirements as appropriate in the field of flatrack and container model operations.

<u>On-going and Future TAVOP Initiatives</u>

In support of the peacekeeping missions in **Bosnia**, the TAVOP team was asked to provide the TAV integration and prototyping support required to migrate all recently demonstrated improved TAV (AV/ITV) capabilities to U.S. Army Forces in Europe as quickly as possible, culminating in the development and installation of a TAVOP-Europe tailored specifically to support the Commander, U.S. Army Europe (USAREUR) and in particular, the on-going Bosnia

mission. The Army requires the ability to track and control the deployment of its assets worldwide in "real time" deployments, in this case, to Bosnia. In an effort to develop a more cost effective and streamlined logistics effort which provides for complete information on the location, status, and availability of all classes and categories of supply, the Office of the Deputy Chief of Staff for Logistics (DCSLOG), USAREUR is implementing a theater specific effort known as the Logistics Data Network (LOGNET), a component of which is the integration of TAV data services in Europe. As a starting point for LOGNET, a TAVOP ITV server is operational in the European theater as part of TAVOP initiated previously by the Logistics Integration Agency (LIA) and the Office of the DCSLOG. Connected to this server is a network of RF tag burn stations and interrogation sites. The server is accessible via the DDN/Internet, and is used by military commanders in Germany to gather timely information on cargo and equipment movements into Bosnia. The DCSLOG has the opportunity to capitalize on this initial ITV capability, especially considering its on-going Bosnia efforts, and quickly expand LOGNET and its associated ITV capabilities to other high priority target user communities in Europe.

The TAVOP team is also currently involved in efforts to integrate TAVOP into the **Korean Theater**. Building upon the larger scale development and field testing of the Army TAVOP in Europe and now, Bosnia, preparatory activities, such as site and user surveys, were conducted by the TAVOP team in Korea in parallel with these efforts. As an enhancement of these efforts, LIA is currently involved in designing and integrating a relatively comprehensive A-TAV operational prototype that involves RF tag technology, an ITV proof-of-concept and interfaces with legacy and target information systems. This effort will build on the current CINCVIEW capability to include Army In-Transit Visibility. The ultimate objective is to establish, as quickly as possible, an Army TAVOP capability that is specifically tailored to support the unique environment and exacting needs of the Korean Theater.

Future Applications of TAVOP

As part of the future development of TAVOP and its use of AIT, other opportunities will emerge which can take advantage of these capabilities. The following list includes potential areas and functions which may be incorporated into future TAV capabilities as designed by its proponent/users. The opportunities listed are not exhaustive and additional areas of consideration may emerge with further studies and advancing technologies.

- Tracking unit movement to and within a theater. This may be accomplished by attaching RF tags to vehicles and locating interrogators along movement routes.
- Aide in property book accountability of major end items. This may be done by attaching RF tags or other AIT devices to major end items, to include equipment other than vehicles.
- Monitoring the maintenance of equipment at the direct/general support maintenance points. By capturing data from SAMS, logistics managers may monitor the status of equipment in maintenance.
- Monitoring dispatched vehicles. Dispatchers may be able to monitor vehicles leaving and entering the motor pool and location while dispatched, if interrogators are used at various choke points. This may provide information on authorized usage/dispatch, route of movement, and current location.
- Identify logistics bottle necks. This may be accomplished by compiling data from various interrogators along lines of communication.
- Support deliberate and crisis planning. Data may be compiled to provide time and space analysis of expected logistics processes, such as unit movement, unit reconstitution, and logistics resupply.

SMALL PACKAGE SORT FACILITY (SPSF)

by
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Introduction

Transitioning the Army into the 21st century demands a quantum leap to improvements in efficiency and effectiveness. No aspect of the Army's force projection policy is exempt from being in sync with the ensuing transition. This includes the processes of combat service support (CSS) and the Army's logistics concepts. This transition is dependent on the Army holistically embracing the improved processes and evolving technologies that will place the Army squarely in tune with the emerging Information Age and maintain its status of the supreme fighting and peacekeeping force of this century and the next. The commander of forces employed in any theater of operation, on any mission, would find it of great value if current CSS/logistics requirements could be supplied as rapidly as any commercial delivery service.

Specifically, the Army must be able to receive supplies in any theater of operations as rapidly as the distribution system in Continental United States (CONUS) can ship them out. Commercial distribution industries today can process millions of packages on a daily basis, with almost negligible loss and damage. Successful commercial systems usually employ variations of a "hub and spoke" system, whereby packages are received at major hubs and sorted for delivery to smaller, regional hubs and then in turn to the customer. The Army is moving toward adapting such commercial "hub and spoke" systems in its Battlefield Distribution concept. Battlefield Distribution is a fully integrated distribution management methodology that utilizes existing and emerging technologies; limited organizational restructuring; improved doctrine; and reengineered procedures/business practices. Once fully developed Battlefield Distribution will improve combat capability, improve performance in the distribution of materiel, units and personnel, improve command and control, ,properly size, configure and position materiel to support the soldier, and improve soldier confidence in the Army's CSS process.

The "hub" of our system is the Distribution Terminal which serves Supply Support Activities (SSA) located at the perimeter of the "wheel." Lines of communication, usually truck or rail delivery, are the "spokes." To handle the volumes of small packages expected, a Small Package Sort Facility (SPSF) situated within the Distribution Terminal, or further forward on the battlefield (if needed) is required. An SPSF will provide the Army, and other Services as well, with a much improved capability to rapidly receive, sort and distribute critical small packages to users in forward areas. This requirement, although primarily a CSS mission function, strongly supports combat and combat support functions, as well.

Today

The Army's current distribution system cannot handle individual small packages quickly from multiple sources to destination. Currently, small packages must be consolidated for shipment and cannot be tracked in route, although much technological progress is being made in this area. The current system has an extremely slow Order Ship Time (OST) that causes supply clerks at user level to (1) stockpile/hoard supplies, (2) flood the supply system with requisitions and back orders, or (3) completely lose faith in the integrity of the supply system. Because the current distribution system is cumbersome and static, it quickly and easily becomes stockpiled over its maximum capacity, thus making it even more static. As combat operations move forward, supply support is stretched to its limits, making OST even longer. The time has come to move ahead: adaptation of best commercial practices, such as the SPSF, coupled with asset tracking systems and Automated Information Technology (AIT) can put the Army on an equal footing with state-of-the-art distribution systems. The SPSF does not attempt to solve the challenge of distribution in the Army, but rather focuses on expediting distribution of critical small packages. It is a conservative estimate that 13,954 S/T or 27,908,000 lbs of small packages passed through Dhahran AB alone during Operation Desert Shield/Storm (August 1990-February 1991). An untold number of these packages were mishandled, misrouted and just plain mismanaged, causing users in forward areas to be at less than Fully Mission Capable (FMC) status.

The Future

The SPSF in appearance will resemble, on a much smaller scale, fixed facilities used in state-of-the-art commercial distribution centers. These centers include such things as AIT devices to rapidly scan package shipping labels, conveyors or roller systems to move packages from the incoming conveyance such as aircraft shipping containers, etc., to the outbound container, truck, etc., loading and unloading platforms or docks, and a work area protected from the elements. The SPSF is a small, modular, flexible, deployable facility which can receive, sort, distribute, redistribute and retrograde small packages in support of a variety of military operations. The SPSF could be located at the area Distribution Terminal and is intended to handle supplies and possibly mail: i.e., Class II - CTA 50-900 items, Class III P - Lubricants and petroleum products, Class VI - Health and comfort items, Class VIII - Medical, Class IX - Repair parts, Class X - Blankets and other civil affairs materiel inbound from the Air Port of Debarkation (APOD). The SPSF could have the ability to handle presorted bags of mail. It allows for rapid and efficient handling of high priority small package supplies and is an enabler of Battlefield Distribution and Velocity Management. Loads that are already sorted in CONUS to end user or to SSA need not pass through the SPSF but can proceed directly to destination.

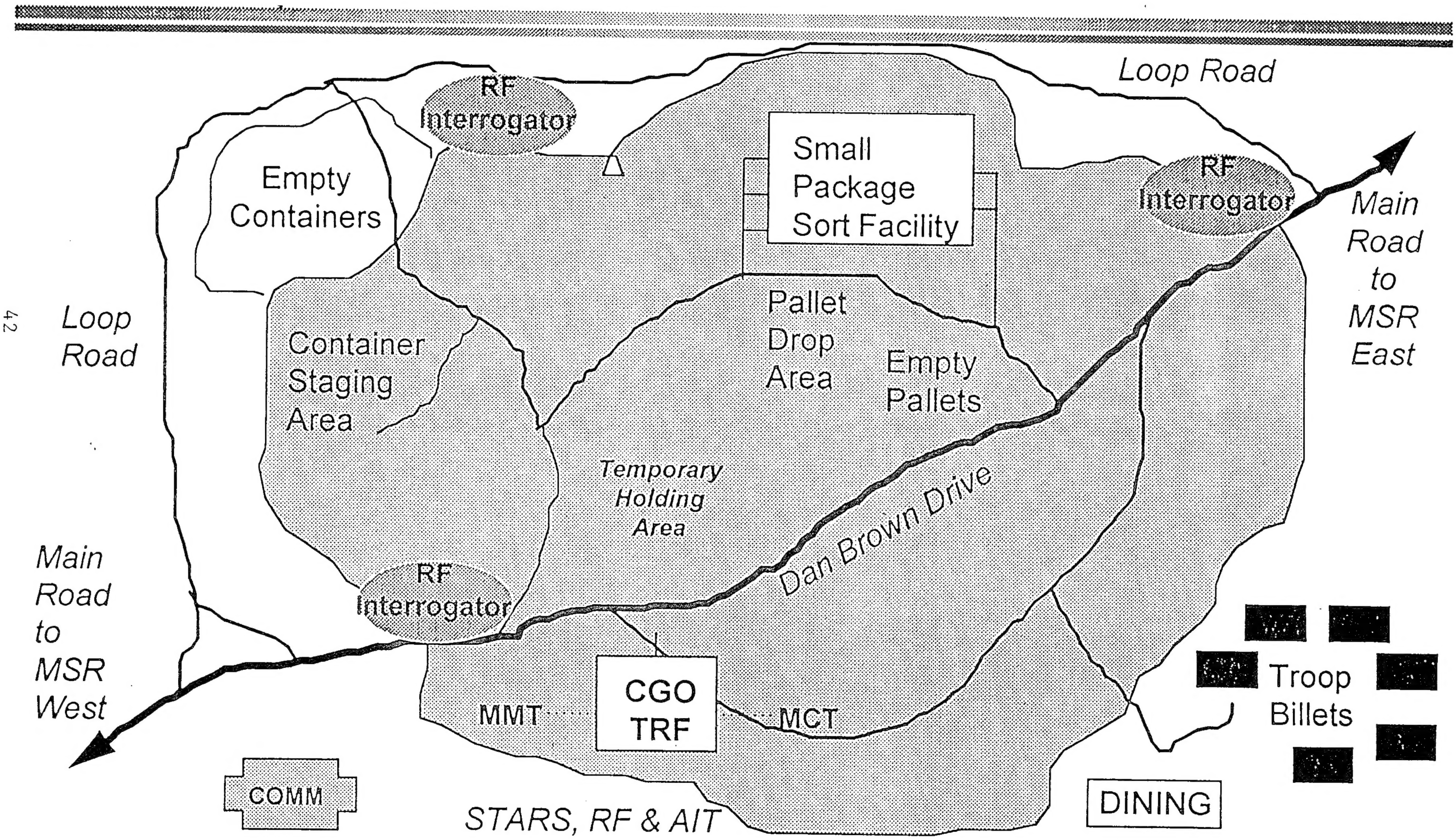
For compatibility with the commercial parcel carrier system, packages must meet commercial parcel carrier (industry standard of, i.e., FedEx and UPS) weight and size constraints of 150 pounds or less and with a maximum girth (as measured around the package) not to exceed (NTE) 130 inches and package length NTE 108 inches. Heavier and/or larger size cargo will be handled by separate processes and locations within the Distribution Terminal. A SPSF will normally be located within the Distribution Terminal of the "Hub and Spoke" system within the area of operation or it may be collocated at the APOD, depending on the threat and other constraints. If necessary, the SPSF should be modular and deployable for movement to austere or undeveloped theaters where suitable Distribution Terminal facilities may not exist or be available for our use from the host nation(s). An SPSF will depend heavily upon AIT and associated Total Asset Visibility (TAV) and In-Transit Visibility (ITV) technologies to identify and track individual packages from source to user. Therefore, SPSF must be fully compatible with current and future AIT developments in this area. Because successful "hub and spoke" operations depend greatly on scheduled transportation capabilities, the SPSF will work within a "time definite" delivery system. The distribution manager will control transportation assets (normally trucks), and these will call upon the Distribution Terminal/SPSF at regularly scheduled times for delivery or retrograde to units in forward areas. The SPSF will eliminate accumulation of cargo at the Distribution Terminal by enabling soldiers to rapidly identify packages (with AIT devices) and conduct sorting operations to or from field users in a single operation at a single location, much like the best commercial practices.

The SPSF will be compatible with and have the capability to have installed the current technology enablers, i.e., Automated Manifesting System (AMS), Standard Army Retail Supply System Level 1 Interim and Objective (SARSS-1 1/0) and Shipment Tracking and Redistribution System (STARS), as part of the inventory and sorting function. From the transportable configuration, it will be able to be rapidly erected and achieve initial operational status in less than 24 hours (12 hours desired) and operate in most terrain, i.e., sandy, desert, beach or rocky areas with minimal need for Engineer support to prepare or level the surfaces for operation. Additionally, the SPSF must be modular and possess an early entry capability (prior to C + 30). The early entry module of the SPSF will be employed as part of the Theater Force Opening Package to facilitate Reception, Staging, Onward Movement, and Integration functions.

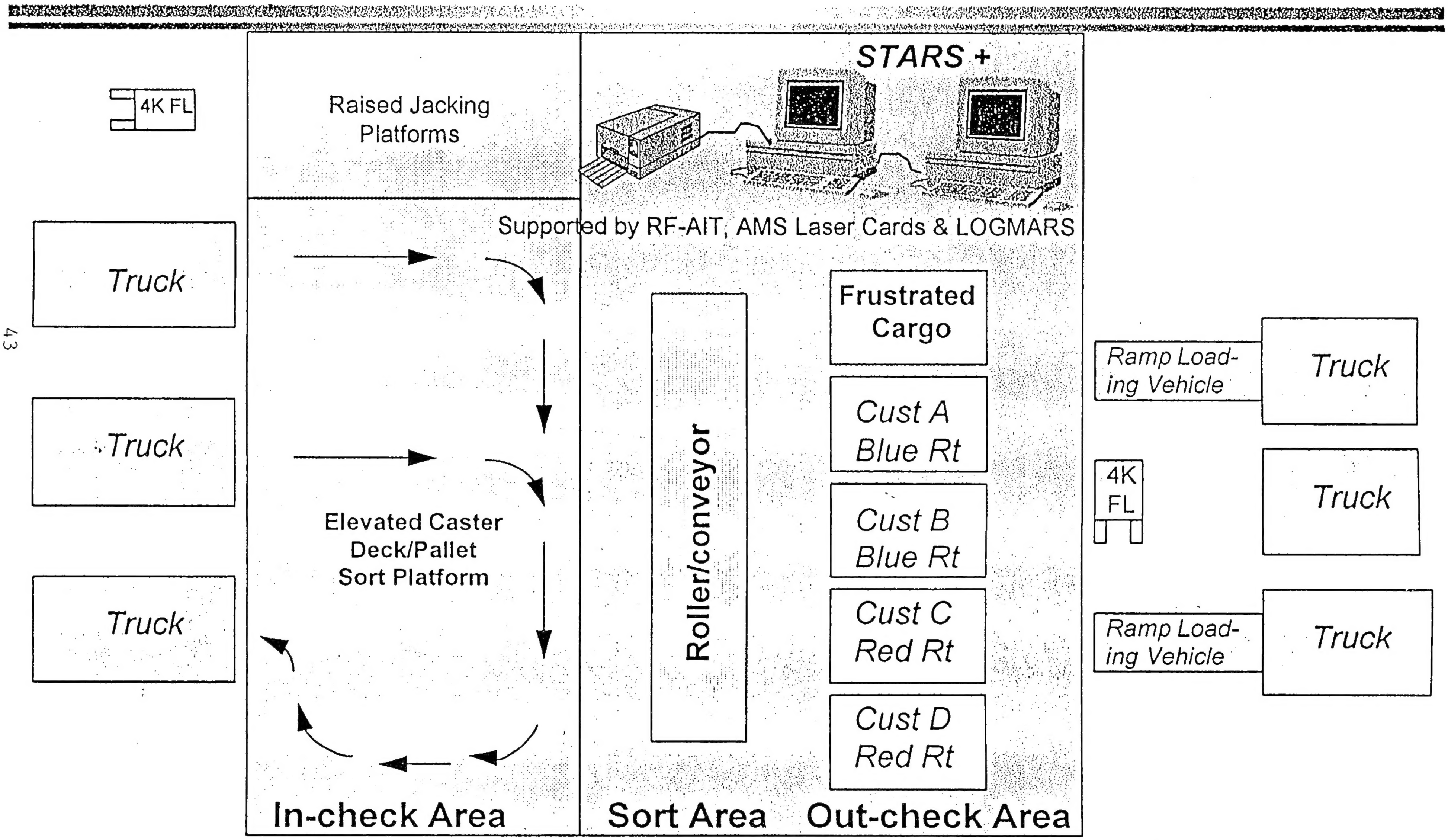
Conclusion

The effect of having a SPSF integrated with Force XXI, Battlefield Distribution (BD), Velocity Management (VM), and Total Asset Visibility (TAV) will have a far reaching positive impact on Logistics Management as we know it. Technological advances have helped reshape the Army as we move into the 21st century. Weapons are designed better, soldiers are smarter and bulky equipment is being replaced with sleek, new aerodynamic gadgets that enhance the soldiers' performance and survivability on the battlefield. Here is the "good news", these items are going to be smaller than ever. It stands to reason that an ever increasing number of small package shipments will be necessary to support our troops. We must be prepared to manage this change. The Small Package Sort Facility will give us the ability to successfully meet the challenges of a rapidly changing logistics environment.

Distribution Terminal Organization



Small Package Sort Facility



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